SHRED
DOCUMENTATION

ZONGE Data Processing
GDP Data Reformat Program
version 3.2x

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November, 1996

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Introduction

The SHRED program reformats data acquired by GDP-16 and GDP-32 Geophysical Data Processors, manufactured by Zonge Engineering & Research. The GDP stores data in an internal software cache, which are transferred to an MS-DOS computer for data processing.

GDP data are in a block format, including measurements for each of up to eight (GDP-16) or sixteen (GDP-32) channels. SHRED rewrites the data in a tabular format, each line (record) representing one measurement composed of several values (fields). This format is more suitable for popular software such as Lotus 1-2-3, MathCad, and dBase.

The block formats are occasionally modified to accommodate data acquisition and processing requirements. The SHRED output files provide a more consistent set of formats, independent of the GDP software version.

SHRED recognizes seven types of data produced by the GDP: Resistivity-Phase Induced Polarization (RPIP), Complex Resistivity or Harmonic IP (CR), Time Domain Induced Polarization (TDIP), Transient Electromagnetics (TEM), Controlled-Source Audio-Frequency Magnetotellurics (CSAMT), Harmonic CSAMT (HACSAMT), and Natural-Source MT (AMT). GDP data formats are recognized beginning with version 5.05.

The GDP custom program TDCS is not recognized by SHRED.

Array types for RPIP, CR, and TDIP surveys include Dipole-Dipole (D-D), Pole-Dipole (P-D), Pole-Pole (P-P), Down-Hole (D-H), Schlumberger (SCH), and Gradient (GRD). The Laboratory (LAB) array type is defined for CR measurements.

Array types for CSAMT surveys include Grounded (AMT) and Insulated (ISL). The only HACSAMT array type is AMT. The array types for NSMT (AMT) are Vector (VEC) and Scalar (SCA).

Array types for TEM surveys include In-Loop (INL), Fixed-Loop (FXL), Coincident-Loop (COL), Moving-Loop (MVL), and LOTEM (LOT).

The SHRED program is compiled by the Microsoft "C" v6.00 compiler.

Usage

At the DOS prompt, type SHRED. A summary of the operation of the program will be displayed. To process a GDP data file, type SHRED followed by the name of the file to be processed. A GDP data dump file is expected, using the extension ".RAW" (unless the complete filename is entered). If a pathname is specified, output files will be written to the current subdirectory. Include additional options as needed.

Usage (cont'd)

```
C> shred
ZONGE ENGINEERING: 3322 E. Fort Lowell, Tucson AZ 85716, USA
SHRED 3.20: GDP DATA CONVERSION Program
   MS-DOS version implemented 18 August 1993.

Usage: SHRED pathname [ [arg1] [arg2] ... ]
Arguments: (default options in uppercase)
  Pathname extension       : pathname.RAW
  Auto file delete         : yes= /a+,   NO= /a-
  Sort data records        : YES= /s+,   no= /s-
  Split data records       : yes= /d+,   NO= /d-
  Recalc Rx or Stn         :  RX= /Rr,  stn= /Rs
  Harmonic Phase Invert    : yes= /p+,   NO= /p-
  TEM data includes        : MAG= /Tm,  rho= /Tr
  Include Cal/Sys/Ref      : yes= /c+,   NO= /c-
  ComBine CSAMT AND HACSAMT: yes= /b+,   NO= /b-
C>
```

COMMAND LINE ARGUMENTS: (default values are capitalized)

AUTO (yes or NO)

An existing output file will not be overwritten without permission.

SORT (YES or no)

Sort data records by Stn/N-Sp, Component, Frequency, Block Number.

SPLIT (yes or NO)

Data records of different types may be written to separate files.

RECALC (RX or stn)

Rx values may be calculated for D-D, P-D and P-P arrays, when Tx and Rx refer to the shallowest N-Spacing in the data block, and each value is the dipole end with the lowest station number.

For OTHER arrays, Stn values may be recalculated, adding the Stn value to the Rx value for each channel (uses Stn as Rx offset).

	D-D,P-D,P-P	OTHER arrays
RX:	RECALC Rx	Same Stn
stn:	Same Rx	RECALC Stn

PHASE INVERT (yes or no, default is AUTO)

CR D-D harmonic data are plotted in the 1st quadrant (positive phase), while data are measured in the 4th quadrant (negative phase). The GDP records inverted harmonic phase data to version 5.20. Later versions record data as measured. The Phase switch inverts the sign of harmonic phase data, for all versions and array types.

AUTO mode is used when the /P switch is not specified. Harmonic phase data for versions after 5.20 will be inverted for geometry-dependent array types (all CR array types except MMR).

TEM (MAG or rho)
TEM data records may include magnitude OR resistivity values.

CAL (yes or NO)
Include Reference channels, Calibrate, System, and SYNC blocks in the output file.

COMBINE (yes or NO)
CSAMT and HACSAMT data at one station will not be combined.

Software Operation

Type SHRED at the DOS prompt, followed by the filename to reformat, and any of several options. If a filename is not entered, instructions will be displayed.

If the input filename does not specify an extension, ".RAW" is assumed. The output filename uses the extension ".FLD", and is written to the default drive and directory.

The program reads GDP data blocks and creates one line (record) for each measurement. A measurement may consist of one (typical) or two (as for scalar CSAMT and AMT) channels of data. The GDP normally collects a series of data blocks at each of several setups, measuring components for one or more locations. A setup is defined as a sequence of data blocks with the same Program Type, Array Type, Line, Spread, A-Spacing, Tx, and Rx values.

SHRED will, by default, sort the shredded data blocks for each setup, then write the records to the output file. Refer to "Sorting the data file" for a list of the sort index fields.

The GDP program records values in an engineering format, using letters to represent the exponent. SHRED translates these letters to an exponential format:

----- UNIT -----	EXPONENT ----
"T"	"e12"
"G"	"e+9"
"M"	"e+6"
"K"	"e+3"
" "	" "
"m"	"e-3"
"u"	"e-6"
"n"	"e-9"

Values that need to be recalculated are scaled in a similar manner, then included in the file. A field may have a fixed width, with the decimal location floating within the field.

If a particular value does not contain any of the unit letters, but is in a field that at times requires this scaling, three blank spaces will be added to the end of the value.

Each column in the output data file contains either the maximum number of characters allowed, or is padded with blank spaces to align columns. Each entry is treated as a string of characters, so the number of spaces between values is not critical.

Calculation of Receiver Location

The Receive (Rx) value should indicate the GDP location, for CSAMT, CSHA, AMT, and TEM surveys (by convention). Station locations are entered for each channel. The command line switch "/Rs" indicates that station values are relative to the Rx value, and a calculated station value will be included for each channel.

Dipole-Dipole, Pole-Dipole, and Pole-Pole arrays for RPIP, TDIP and CR surveys define the N-Spacing (Tx and Rx dipole relationship). By convention, the Rx value indicates the closest Rx dipole to the Tx dipole, for the channels measured. Rx locations are calculated or copied for each channel, according to the command line switch "/Rr" or "/Rs".

SHRED determines the smallest N-Spacing for each data block. The scale factor and Rx location are calculated by:

```
   Rx:          Receiver    (dipole end with lowest station number)
   Tx:          Transmitter (dipole end with lowest station number)
   Rxc:         Receiver location for that N-Spacing
   min_NSp:     minimum N-Spacing defined by the Rx - Tx separation
   NSp:         N-Spacing defined for each station (channel)

   D-D array:  Scale= (Rx-Tx) / (min_NSp+1)  Rxc= Tx + Scale *
(NSp+1)

   P-D, Rx<Tx: Scale= (Rx-Tx) / (min_NSp+1)  Rxc= Tx + Scale *
(NSp+1)
   P-D, Tx<Rx: Scale= (Rx-Tx) / (min_NSp)    Rxc= Tx + Scale * (NSp)

   P-P array:  Scale= (Rx-Tx) / (min_NSp)    Rxc= Tx + Scale * (NSp)
```

Survey Configurations

	RPIP					CSAMT	AMT	
SURVEY METHOD -->	TDIP	CR	SURVEY METHOD	-->	TEM		CSHA	
ARRAY-TYPE	LABEL			ARRAY-TYPE	LABEL			
Dipole-Dipole	D-D	*N *N	*NC	Grounded	AMT --	+SC	+SC	---
Pole-Dipole	P-D	*N *N	*NC	Insulated	ISL --	+SC	---	---
Pole-Pole	P-P	*N *N	*NC	Scalar	SCA --	---	---	+SC
Down-Hole	D-H	+N +N	+NC	Vector	VEC --	---	---	+SC
Schlumberger	SCH	+M +M	+MC	In-Loop	INL +S	---	---	---
Gradient	GRD	+R +R	+RC	Fixed-Loop	FXL +S	---	---	---
Laboratory	LAB	-- --	+x	CoincidentLoop	COL +S	---	---	---
Magnetometric	MMR	-- --	+ C	Moving-Loop	MVL +S	---	---	---
				LOTEM	LOT +S	---	---	---

Rx Definitions

```
     -: undefined survey array       S: Station
     +: Rx value used                N: N-Spacing
     *: Rx recalculated per N-Sp,    M: A-Spacing multiplier
        for /R+ switch (default)     R: A-Spacing multiplier,
     x: undefined value                 relative to Rx
                                     C: H-field value is COIL NUMBER
```

Sorting the data file

Each data point consists of a set of values for a range of times or frequencies. Each GDP data block contains some values for several data points, measured at one frequency. Shredded but unsorted data files require other programs to filter the data for each data point before averaging or plotting the data. SHRED simplifies this task by writing sorted records grouped by data point.

Data blocks are shredded as they are read from the input file. A single digit sequence number is incremented when any of a set of fields changes. Usually, each sequence number indicates data acquired at one survey setup (one GDP location).

A SURVEY SETUP change is defined by a change in any of these fields:

FIELD_NAME	TIME_DOMAIN_FIELDS	
1. Program type	9. Duty Cycle	(TEM)
2. Array type	10. Receiver Moment	(TEM)
3. Cal, Sys, Data blocks	11. Tx X & Y lengths	(TEM)
4. Line number	12. Number of turns	(TEM)
5. Spread number	13. Tx Delay, Antenna Delay	(TEM)
6. A-Spacing	14. Frequency	(TDIP & TEM)
7. Tx value		
8. Rx value		

Each set of records with one sequence number is sorted (by default) then written to the output file. The fields used for sorting may also increment the sequence number, so that one value indicates a set of records for one data point. At this time, the sort routine can handle up to 9000 measurements per survey setup.

The SORT FIELDS for data at each SURVEY SETUP include these fields:

FIELD_NAME	SORT_DIRECTION	SEQUENCE_CHANGE
1. Station # / N-Spacing	(ascending)	yes
2. Component	(ascending)	yes
3. Frequency	(descending)	no
4. Block number	(ascending)	no

The SHRED output data file is read by Zonge data processing programs. One station or data point is identified by a set of records with the same sequence number.

If the original or SHRED data file has been edited, or several files combined into one, then the sequence number may need to be modified so that adjacent data points do not use the same sequence number.

Splitting the data file

The GDP .RAW-file may contain data for more than one survey type. All data will be written to the .FLD-file. The SPLIT option will rewrite .FLD-file data records to files that each contain one type of data. The extensions .CR, .TEM, .RP, .TD, .CSA, .CSH and .AMT will be used, according to the header record survey types.

Data Processing Flags

GDP data blocks define a Skip Flag to be an "x" character between the version number and the date. Skip Flags indicate data blocks that should not be included when averaging field data. The SHRED output data formats define an Average Flag to be a "0" for records that should be skipped, and a "1" for records that should be included.

Skipped data may need to be included later, so data blocks are NOT deleted. All data are included in Zonge DATPRO summary data listings (but not averaged). Survey locations (Tx, Rx, N-Sp, Stn, ...) must be accurate for skipped data blocks.

Inconsistent field procedures may result in a failure to maintain consistent polarity on any channel. Surveys using a Time Domain procedure (TDIP and TEM) are affected by a change of sign of the magnitude values. Frequency Domain procedures (RPIP, CR, CSAMT, CSHA) are affected by the phase value being inverted by pi.

The GDP does not provide for the operator to indicate that any channel has a polarity problem. The SHRED format defines a Polarity Flip Flag for each component, that defaults to "0" to indicate that there is not a problem. A Flag set to "1" indicates that data processing programs should correct the data, by inverting the sign of magnitude values (Time Domain) or adding/subtracting pi to the phase value (Frequency Domain).

SHRED defines a Skip Flag and Polarity Flip Flag for each channel. The GDP does not provide these flags. The space between the channel number and component label may be any of four values:

```
" ":  no change (default space)
"x":  SKIP FLAG for this channel
"-":  POLARITY FLIP FLAG for this channel
"b":  Both SKIP FLAG and POLARITY FLIP FLAG for this channel
```

A text editor may be used to set appropriate values according to field notes. The original format must be preserved: do not allow values to be shifted left or right. The text editor must be able to preserve the original format without adding text format characters. MS-DOS 5.00 and later provides the EDIT program, which is suitable.

The GDPRAW program preprocessed GDP-16 data prior to conversion to GDP-12 data formats and processing by GDP-12 specific programs. The GDPRAW output files contained data processing Skip Flags and, for some data types, Polarity Flip Flags. These files used the filename suffixes ".AF", ".RF", ".CF", ".EF", and ".TF". SHRED will read these files and set the flags as indicated.

The AVERAGE FLAG defaults to "1". It is set to "0" when the block SKIP FLAG is "x", the channel SKIP FLAG is "x" or "b", or the GDPRAW AVERAGE FLAG is "0". For CSAMT records that include two channels of data, the AVERAGE FLAG for the record will be set to "0" when either of the channels so indicates.

The POLARITY FLIP FLAG defaults to "0". It is set to "1" when the channel POLARITY FLIP FLAG is "-" or "b", or the GDPRAW POLARITY FLIP FLAG is "1".

Comment and Program Control Lines

Data processing programs that read .FLD-files should recognize lines defined as Comment or Program Control ("MODE") lines.

Comment lines include a "", '!', '\', '/', or '/*' in the first column. SHRED reads comment lines and writes them to the .FLD-file.

Program control "MODE" lines include a '$' or '\$' in the first column. SHRED writes MODE lines to the .FLD-file without affecting program flow, except as noted later.

ZONGE data processing programs read MODE lines for names and values. The form is: "$ PRGM_NAME: MODE_NAME= value". PRGM_NAME optionally specifies a program name, which will associate the MODE_NAME and the value to the appropriate internal variable name, value, and data type.

Transmitter Current Corrections

Data block 'Tx Curr' values may be corrected by entering the MODE line "$ SHRED: CURRENT= value" before the first data block to be corrected. Enter additional mode lines as needed. A line "$ SHRED: CURRENT=" will use the existing data block value.

The "Tx Curr" values will be replaced by the mode line value. Data values will not be modified, except for TEM Magnitudes that will be adjusted in volts/amp.

AMT Correlation Coefficient Filter

SHRED can reduce the size of large AMT files by rejecting measurements whose Correlation Coefficient is less than a specified value. For example, include "$ SHRED: CL= 0.800" to limit the output file to records whose CL value is 0.800 or greater.

System and Antenna Calibrate Data

Calibrations remove amplitude change and phase shift from measured values due to antialias and powerline notch filters, and correct for gain differences between channels.

For frequency domain signals, amplitude and phase variations due to filters are removed by dividing field voltages by the normalized calibrate magnitude, and subtracting calibrate phase from measured field phase. This is done frequency-by-frequency.

For time domain signals, only amplitudes are corrected for distortion due to filtering.

Data are decalibrated by the GDP, using calibrate cache values. GDP data need to be modified if appropriate calibrates were not loaded, or other adjustment is needed. All recognized GDP data types except Natural Source AMT data can be adjusted by SHRED.

Only raw magnitude and phase values are corrected. Averaging programs are expected to recalculate values such as resistivity.

Modify a GDP data file by typing SHRED, the data file name, and the calibrate file name containing values in Calibrate Cache format (Appendix C). Calibrate values from the Field Data Cache are NOT appropriate! If SHRED notes a problem while reading the calibrate file, a message will be displayed, and the data file will NOT be processed.

The calibrate file may contain several sets of calibrate values. Include "$ SHRED: INCLUDE" or "$ SHRED: REMOVE" before each set of values. The GDP does a REMOVE: magnitude data are divided by calibrate magnitudes, and calibrate phases are subtracted from phase data.

Include good and bad sets of values in the calibrate file, preface the BAD calibrate with an INCLUDE statement, and the GOOD calibrate with a REMOVE statement.

H-field phase data measured by the CR programs prior to version CR__0520 were provided with the sign reversed (negative phase values should be positive). Corrected H-field data requires restoring the antenna calibrate, changing the sign of phase values, then removing the calibrate again (or other suitable calibrate). Due to the methods used by the GDP, the system calibrate is not involved.

Repair H-field phase data by creating a file with the original antenna calibrate. Include "$ SHRED: FIXPHZ" before the calibrate. Append a suitable antenna calibrate (usually the same calibrate), and include "$ SHRED: REMOVE" before it. SHRED will restore the calibrate, change the sign of the phase data, then the second calibrate will be removed to obtain the corrected results.

A system calibrate may also be used with the FIXPHZ procedure, to repair phase data for all components measured.

Calibrate files are not required to include all frequencies and channels (or coils). However, complete sets of calibrate values are recommended, with Magnitude = 1.000, Phase = 0.000 for data that does not need to be modified. No message is provided when values are provided for some frequencies or channels and not for others.

The order of calibrates does not matter. FIXPHZ values are accumulated in one buffer, INCLUDE and REMOVE values in a second. FIXPHZ values will be applied first.

Various types of data may be included in a data file that needs to be modified. However, only ONE type of data will be modified, according to the content of the calibrate file. Also, ALL data of that type will be modified. Separate data and calibrate files are required for each modification that is needed.

SUMMARY:

$ SHRED: REMOVE	"subtract cal"	divide by mag; subtract phz
$ SHRED: INCLUDE	"add cal"	multiply mag; add phz
$ SHRED: FIXPHZ	"add, flip phz"	multiply mag; add phz, flip sign

Data Structure

Header blocks contain information that is assumed to apply to all data blocks that follow, until another Header block occurs.

The first section of each Data block contains reference data. The second section contains one line for each channel, including measured values and reference information. A third section is included for CR, TDIP, TEM, CSHA and AMT data, containing additional measured values for each channel. The structure is unique to each survey type.

GDP-32 data provides for up to 16 channels, so the channel line formats will shift by one character when 10 or more channels are in use.

HEADER Data Block

Header blocks may appear anywhere in the data file, and one should be at the top of each data file. If a Header block is not the first block in a file, default values are used:

OPER	TX_ID	A-SP	LINE	SPREAD	JOB
0	0	100	1	1	0

Several lines at the end of the Header block may include an inventory of hardware installed for each GDP channel. This information will be discarded by SHRED.

Header block data are assumed to apply to each Data block that follows, until another Header block occurs, or the end of the file. A skip flag has no meaning in a Header block. Several Header blocks in sequence merely replace the data from the previous block. Only the information in the last Header block of the group is used by SHRED.

Sorted data includes a record containing the current header block information followed by the data records for each data point. This will serve as a visual divider in unsplit data files.

RPIP Data Block

The RPIP data block has a header section followed by several lines consisting of several columns of data. Each line corresponds to one data acquisition channel. The header section is read, its data formed into a string that is included at the beginning of each record written for that data block.

The value for the receiver location (Rx) is calculated for each channel to show its actual location with respect to the N-spacing (with the "/Rr" default command line switch in effect). The data are then read one line at a time and processed until the end of the block is reached.

The version and array type are not written to the output file since they are in the header block. The notch filter and calibrate values are discarded.

CR Data Block

The CR data block channel data are in the same format as RPIP data. Following the channel data is a table of magnitude and phase values for the 1st, 3rd, 5th, 7th, and 9th harmonics for each channel. SHRED matches channel data with the corresponding harmonic data.

The receiver location is copied or calculated as for RPIP data, then the channel data and harmonic values are written as one record.

CR dipole-dipole phase data are normally measured as negative values. By convention, these data are plotted in the first quadrant (positive phase) instead of the more natural fourth quadrant. This interferes with Harmonic EM measurements, so beginning with version CR__0520 the harmonic phase values are not negated by the GDP.

SHRED will automatically invert harmonic phases for all geometry-dependent array types (all CR array types except MMR). The command line switch /P is available to force SHRED to invert or not. Use /P+ to invert harmonic phases, or /P- to not invert them.

TDIP Data Block

TDIP data blocks are similar to the RPIP structure, and include window information below the channel data, where one column corresponds to each channel. Each column is transformed into a row and appended to the corresponding channel data. There are thirteen window magnitude values for each channel.

TEM Data Block

TEM data blocks are similar to the RPIP structure. The channel data lines have several columns of values, one difference being that the column containing the SEM value may now have an exponent, whereas all other survey types do not. In addition to the channel information, the TEM data block also has a table containing window times and magnitude values. Resistivity values may be included, dependent upon the array configuration.

Column labels form the first line of the window table. The GDP allows up to three channels for TEM surveys. SHRED provides for up to five channels, so the table may include eleven columns. The first column, labeled "Wn", contains window times. The rest of the columns contain magnitude or resistivity data for each channel.

The information for each channel is written to the file as a single record. The channel data are followed by the sampling delay, alias delay, first window time and sampling interval. A command line switch specifies whether to include the label "Tm" and window magnitudes, or the label "Tr" and resistivity values. If all channels were measured, the resulting record length will approach 600 characters.

CSAMT Data Block

CSAMT data blocks are also similar to the RPIP structure. One CSAMT measurement includes E- and H-field components. Each channel measures the signal from an electric dipole or magnetic coil.

SHRED will read the entire data block, then pair the E- and H-field channels as follows:

1. For every Ex channel found, SHRED will look at the following channels for the first Hy channel, then it includes both Ex and Hy channels in one output record.

2. For every Ey channel found, SHRED will look at the following channels for the first Hx channel, then it includes both Ey and Hx channels in one output record.

3. When the corresponding H-field data are not available, the E-field data and default H-field values will be included in the output record.

4. There may be an Hz channel included, which will not have any corresponding E-field data. Default E-field values and the Hz channel data will be written to the output file.

The station location will be copied or calculated according to the "/R" command line switch. If copied (/Rr switch), station locations from the channel data lines are used. Otherwise (/Rs switch), the station values are used as offsets to the Rx value.

CSHA Data Block

The CSHA data block has a format similar to the CR data block, with each channel measuring either an E-field (electric dipole) or H-field (magnetic coil) component. One complete measurement usually requires both E- and H-field data.

SHRED will read the entire data block, then before writing it to the output file the program pairs the E- and H-fields in the same manner as for CSAMT channels.

AMT Data Block

AMT data blocks are similar to the CSAMT structure, with E- and H-field channels paired. If Ex is measured, Hy must be included. If Ey is measured, Hx must be included. Hz is optional. Data are included for harmonics 1, 2, 3, 4, 5, 6, and 7.

Each data block includes a second section containing additional values for pairs of components.

Appendix A ... GDP Data Block Structures

Sample GDP HEADER BLOCK

```
0079
TEM 0530 93-07-10 11:01:59 13.7v INL
OPER         1 TX ID    1 A-SP    100
JOB 93001 LINE        1 N  SPREAD  1
100% RxM  10000 TxX    1 TxY    1 #T  1 Ref 0.113    (TEM DATA ONLY)
Tx Delay   50 Antenna Delay   15 Alias IN            (TEM DATA ONLY)
1 DiffAmp Notch+60,3-5,9  S/N    4 Passed 0.99863
2 DiffAmp Notch 60,3-5,9  S/N    8 Passed 0.96621
3 LoPass  Notch+60,3-5,9  S/N   69 Passed 0.99767
```

Header block input file structure

-- FIELD_NAME -------	UNITS --	RANGE ---	TYPE ------	WIDTH --	END --
Line 1					
Block Number	#	0 - 9999	Integer	4	4
Line 2					
Survey Type	-	ex:"TEM "	Character	4	4
Version Number	#	0 - 9999	Integer	4	8
Skip Flag	-	x or space	Character	1	9
Date	date	dd mmm yy	Date	8	17
Time	time	hh:mm:ss	Time	8	26
Voltage	v	0 - 99.9	Scaled	5	32
Array Type	-	ex:"INL"	Character	3	36
Line 3					
Operator	-	ex:"JOHN"	Character	9	14
Tx Id	-	ex:"ONE"	Character	4	25
A-Spacing	m	positive	Scaled	6	37
Tx Shunt (CR or RPIP)	Ω	positive	Scaled w/exp	5	46
Line 4					
Job Number	#	ex:"GOLD"	Character	5	9
Line	#	ex:"1+00"	Character	8	28
Line Direction	-	ex:"N"	Character	2	31
Spread	#	ex:"A"	Character	2	41
Ax (Grd, Sch Arrays)	#	±0-9999999	Scaled	8	48
Bx (Grd, Sch Arrays)	#	±0-9999999	Scaled	8	60
Correlation Limit (AMT)	#	0-0.999	Float	5	45
FFT Function (AMT)	-	HANN or RECT	Character	4	50
Outlier Limit (AMT)	#	0.01-100.00	Float	6	65
De-Meaning (AMT)	-	ON or OFF	Character	3	69
De-Meaning (AMT)	-	ON or OFF	Character	3	73
Line 5 (TEM data ONLY)					
Duty Cycle	%	50 or 100%	Character	3	3
Receiver Moment	m^2	1 - 999999	Integer	6	15
Tx Length (X)	m	1 - 9999	Integer	4	24
Tx Length (Y)	m	1 - 9999	Integer	4	33
Tx Loop turns	#	1 - 99	Integer	2	39
Coil Reference Factor	#	.001 - 9.999	Float	5	49
Line 6 (TEM data ONLY)					
Tx Turnoff Delay	µs	1 - 9999	Integer	4	13
Rx Antenna Delay	µs	1 - 9999	Integer	4	32
Alias Filter	-	ex:"OUT"	Character	3	42

Line 7+ hardware inventory information, one line for each channel.

Sample GDP RPIP DATA BLOCK

```
0003
RPIP0530 92-09-30 15:58:40 13.0v D-D
Tx        1 Rx        3 N 50,60
   1 Hz      1 Cyc Tx Curr     1
1  ON     1   2.2339    104.4   99.2  000O   0.00   19.74   225  0
2  ON     2   0.6051    105.3  107.5  001O   0.02   -3.16 -95.7  0
3  ON     3   0.2895    103.6  128.6  002O   0.00  -10.99  -171  0
4  ON     4   0.1742    104.1  154.8  002O   0.00    7.32  -199  0
```

RPIP input data block structure

-- FIELD_NAME -------	UNITS --	RANGE ---	TYPE ------	WIDTH --	END --
Line 1					
Block Number	#	0 - 9999	Integer	4	4
Line 2					
Survey Type	-	ex:"RPIP"	Character	4	4
Version Number	#	0 - 9999	Integer	4	8
Skip Flag	-	x or space	Character	1	9
Date	date	dd mmm yy	Character	8	17
Time	time	hh:mm:ss	Character	8	26
Voltage	v	0 - 99.9	Scaled	4	31
Array Type	-	ex:"D-D"	Character	3	36
Line 3					
Tx value	#	±0-9999999	Scaled	8	11
Rx value	#	±0-9999999	Scaled	8	23
Notch value	-	ex:"OUT "	Character	5	31
Int/Ext System	-	ex:"ISys"	Character	4	36
Calibrate Voltage	v	0 - 9.999	Float	5	42
Line 4					
Frequency	Hz	ex:" 1"	Scaled	4	4
Cyc value	#	1 - 16384	Integer	5	14
Tx Current	amps	0 - 99999	Scaled	6	33
Line 4, array type LAB					
Shunt Resistor	Ω		Scaled w/exp	7	44
Rock Sample Length	cm		Float	5	50
Rock Sample Area	cm^2		Float	5	56
Line 5: repeated for each channel measured.					
Channel Number	#	1 - 8	Integer	2	2
Skip Flag	-	sp,x,-,b	Character	1	3
Channel Type	-	ex:"ON"	Character	3	6
N-Spacing	#	0 - 99.9	Scaled	5	11
undefined	-		spaces	2	13
Fourier Magnitude	v		Scaled w/exp	8	21
Phase	mr	±6283.2	Scaled	7	29
Resistivity	Ωm		Scaled w/exp	7	37
Gains/Attenuator	###A	ex:"000O"	Character	4	42
SEM	mr		Scaled	6	49
Self Potential	mv		Scaled	7	57
Contact Resistance	Ω		Scaled w/exp	6	64
External Amp Gain	#	1 - 9	Integer	1	66

Sample GDP CR DATA BLOCK

```
0011
CR  0530 93-07-04 16:05:29 12.8v D-D
Tx        1 Rx        5 N OUT   ISys 1.000
   1 Hz     16 Cyc Tx Curr     1
1  Ex     1   1.2729  -1570.8  78.51K 000O   0.00   -0.41     0  0
2  Ex     2   1.2726  -1570.3  78.40K 000O   0.00   -0.14     0  0
3  Ex     3   1.2731  -1570.6  78.15K 000O   0.00    0.00     0  0
4  Ex     4   1.2727  -1570.3  77.65K 000O   0.00   -2.20     0  0
5  Ex     5   1.2722  -1570.6  76.98K 000O   0.00    0.00     0  0
Harmonics 1               3               5               7 ...
1  1.2729  -1727.0  415.65m -2038.9  239.38m -2350.1  160.63m  ...
2  1.2726  -1729.6  414.70m -2046.2  237.97m -2360.3  159.03m  ...
3  1.2731  -1728.2  415.31m -2042.4  238.77m -2355.4  160.05m  ...
4  1.2727  -1726.3  415.06m -2036.5  238.54m -2344.5  159.72m  ...
5  1.2722  -1729.4  414.92m -2045.7  238.36m -2360.3  159.47m  ...
```

NOTE: Harmonic data are shown through the 7th harmonic magnitude.

CR input data file structure

Refer to RPIP data structure for lines 1 - 4

```
-- FIELD_NAME ------- UNITS -- RANGE --- TYPE ------ WIDTH -- END --
Line 5: repeated for each channel measured.
   Channel Number         #    1 - 8     Integer        2       2
   Skip Flag              -   sp,x,-,b   Character      1       3
   Channel Type           -   ex:"Ex"    Character      3       6
   N-Spacing              #   0 - 99.9   Scaled         5      11
   undefined              -              spaces         2      13
   Fourier Magnitude      v              Scaled w/exp   8      21
   3-Point DC Phase      mr    ±6283.2   Scaled         7      29
   Resistivity           Ωm              Scaled w/exp   7      37
   Gains/Attenuator    ###A   ex:"000O"  Character      4      42
   SEM                   mr              Scaled         6      49
   Self Potential        mv              Scaled         7      57
   Contact Resistance     Ω              Scaled w/exp   6      64
   External Amp Gain      #    1 - 9     Integer        1      66

Harmonic Data Lines:
   Channel Number         #    1 - 8     Integer        2       2
   Magnitude 1            v              Scaled w/exp   8      10
   Phase 1               mr    ±6283.2   Float          7      18
   Magnitude 3            v              Scaled w/exp   8      27
   Phase 3               mr    ±6283.2   Float          7      35
   Magnitude 5            v              Scaled w/exp   8      44
   Phase 5               mr    ±6283.2   Float          7      52
   Magnitude 7            v              Scaled w/exp   8      61
   Phase 7               mr    ±6283.2   Float          7      69
   Magnitude 9            v              Scaled w/exp   8      78
   Phase 9               mr    ±6283.2   Float          7      86
```

NOTE: CR phase data are negated up to CR__0520, to follow the first quadrant plotting convention. SHRED automatically negates harmonic phase data for consistency with data processing programs. Use the command line switch /P to override the default mode.

Sample GDP TDIP DATA BLOCK

```
0072
TDIP0530 92-09-22 14:55:34 13.7v D-D
Tx        1 Rx        3 N OUT   ESys 1.000
.500 Hz      1 Cyc Tx Curr     1
1  ON     1  -1.4992u   210.2 -2.826m 026O   0.00   -0.28     0  0
2  ON     2  -1.3321u   -42.6 -10.04m 026O   0.00    0.00     0  0
3  ON     3  -3.1433u     5.8 -59.25m 026O   0.00    0.00     0  0
Windows
    1       2       3       4       5       6       7       8
      1      -1  982595
   3199   -5614   -1252
   5457     317    5474
  -5833   -5084    -649
   6115   -1588     788
   4234   -4554    1763
  14678    5084   -4036
   6680   -8474   -3340
   5645   -4660    2319
   5080     423   -3340
   3010    1906    2134
   4610    -423   -3572
  11667   -3283   -5428
```

TDIP input data file structure

Refer to RPIP data structure for of lines 1 - 4

```
-- FIELD_NAME ------- UNITS -- RANGE --- TYPE ------ WIDTH -- END --
Line 5: repeated for each channel measured.
   Channel Number          #     1 - 8     Integer         2       2
   Skip Flag               -    sp,x,-,b   Character       1       3
   Channel Type            -    ex:"ON"    Character       3       6
   N-Spacing               #    0 - 99.9   Scaled          5      11
   undefined               -               spaces          2      13
   Primary Voltage         v               Scaled w/exp    8      21
   Chargeability           ms     ±9999.9  Scaled          7      29
   Resistivity             Ωm              Scaled w/exp    7      37
   Gains/Attenuator      ###A    ex:"026O"  Character       4      42
   SEM                     ms              Scaled w/exp    6      49
   Self Potential          mv              Scaled          7      57
   Contact Resistance      Ω               Scaled w/exp    6      64
   External Amp Gain       #    1 - 9      Integer         1      66
```

TDIP input data file window structure follows two header lines.
All 13 rows of the window data are the same:

```
   Channel 1      10*mV/V     Integer     7     7
   Channel 2      10*mV/V     Integer     7     15
   Channel 3      10*mV/V     Integer     7     23
   Channel 4      10*mV/V     Integer     7     31
   Channel 5      10*mV/V     Integer     7     39
   Channel 6      10*mV/V     Integer     7     47
   Channel 7      10*mV/V     Integer     7     55
   Channel 8      10*mV/V     Integer     7     63
```

NOTE: Extremely large values will shift data in the columns that follow.

Sample GDP TEM DATA BLOCK

```
0078
TEM 0530 93-07-16 15:02:03 13.6v INL
Tx        1 Rx        3 N OUT   ESys 1.000
   1 Hz     32 Cyc Tx Curr     1 729.6u  188u  486.4u
1  Hz      1  4.6264u  30.45m  15.54m 060O 1.461u   -0.28     0  0
2  Hz      2  4.8444u  30.45m  15.07m 060O 1.364u    0.00     0  0
3  Hz      3  5.3884u  30.45m  14.04m 060O 1.699u    0.00     0  0
  Wn     Mag 1    Mag 2    Mag 3    Rho 1    Rho 2    Rho 3
 486.4u  22.134m  22.109m  22.105m  12.800m  12.810m  12.811m
 972.8u  17.657m  17.636m  17.639m  7.4854m  7.4914m  7.4904m
 1.459m  14.088m  14.073m  14.071m  5.3568m  5.3606m  5.3610m
 1.946m  11.239m  11.228m  11.230m  4.2787m  4.2818m  4.2813m
 2.432m  8.9677m  8.9598m  8.9658m  3.6622m  3.6644m  3.6628m
 3.152m  7.1598m  7.1498m  7.1509m  3.2859m  3.2890m  3.2886m
 4.127m  5.1350m  5.1284m  5.1287m  2.9735m  2.9761m  2.9760m
```

Line 5 is repeated for each channel measured.
Line 7 is repeated for each window measured (only 7 are shown here).

TEM input data file structure

Refer to RPIP data structure for lines 1 - 3

```
-- FIELD_NAME ------- UNITS -- RANGE --- TYPE ------ WIDTH -- END --
Line 4
   Frequency             Hz   ex:"   1"  Scaled         4       4
   Cyc value              #   1 - 16384  Integer        5      14
   Tx Current          amps   0 - 99999  Scaled         6      33
   Sampling Delay         s              Scaled w/exp   7      39
   Alias Filter Delay     s              Scaled w/exp   5      44
   Sampling Interval      s              Scaled w/exp   7      53

Line 5: repeated for each channel measured.
   Channel Number         #    1 - 8     Integer        1       2
   Skip Flag              -   sp,x,-,b   Character      1       3
   Channel Type           -   ex:"Hz"    Character      3       6
   Station Number         #  ±0 - 99999  Scaled         6      12
   Magnitude   @ RefWin v/a              Scaled w/exp   8      21
   Reference Window Time  s              Scaled w/exp   7      29
   Resistivity @ RefWin Ωm               Scaled w/exp   7      37
   Gains/Attenuator    ###A   ex:"060O"  Character      4      42
   SEM                  v/a              Scaled w/exp   6      49
   Self Potential        mv              Scaled         7      57
   Contact Resistance     Ω              Scaled w/exp   6      64
   External Amp Gain      #   1 - 9      Integer        1      66
```

The magnitude and resistivity table will have up to 31 lines of data. A column of Time is followed by a column of Magnitude (and Resistivity for particular loop types and components) for each channel.

The structure for the three types of columns are:

```
   Time                   s              Scaled w/exp   7
   Magnitude            v/a              Scaled w/exp   8
   Resistivity          Ωm               Scaled w/exp   8
```

Sample GDP CSAMT DATA BLOCK

```
0117
CSAM0530 92-10-21 16:29:15 12.1v AMT
Tx        1 Rx      850 N 60, 5
1024 Hz  16384 Cyc Tx Curr  28.0
1  Ex    600  495.99u  -206.8  244.9  016O   0.76  -22.71  7.62K 0
2  Ex    700  353.53u  -322.9  124.4  026O   0.93   45.39  9.04K 0
3  Ex    800  531.99u  -311.0  281.7  036O   0.55   29.21  5.10K 0
4  Ex    900  638.55u  -341.4  405.9  036O   0.51  -36.76  3.59K 0
5  Ex   1000  573.13u  -333.2  327.0  026O   0.49  -19.34  3.45K 0
6  Ex   1100  940.29u  -325.9  880.2  016O   0.40  -17.93  3.17K 0
7  Hy     590 14.522u -1259.9   933.9 026O   0.54   -7.03   441  0
```

CSAMT input data file structure

Refer to RPIP data structure for structure of lines 1 - 4

```
-- FIELD_NAME ------- UNITS -- RANGE --- TYPE ------ WIDTH -- END --
Line 5, E-field channels
   Channel Number         #    1 - 8     Integer        2       2
   Skip Flag              -   sp,x,-,b   Character      1       3
   Channel Type           -   ex:"Ex"    Character      3       6
   Station Number         #  ±0 - 99999  Scaled         6      12
   Magnitude              v              Scaled w/exp   8      21
   Phase                 mr    ±6283.2   Scaled         7      29
   Resistivity           Ωm             Scaled w/exp   7      37
   Gains/Attenuator    ###A   ex:"016O"  Character      4      42
   SEM                   mr              Scaled         6      49
   Self Potential        mv              Scaled         7      57
   Contact Resistance     Ω              Scaled w/exp   6      64
   External Amp Gain      #   1 - 9      Integer        1      66

Line 5, H-field channels
   Channel Number         #    1 - 8     Integer        2       2
   Skip Flag              -   sp,x,-,b   Character      1       3
   Channel Type           -   ex:"Hy"    Character      3       6
   undefined              #              spaces         3       9
   Antenna/Channel        #   0 - 9999   Integer        4      13
   Magnitude           µTesla            Scaled w/exp   8      21
   Phase                 mr    ±6283.2   Scaled         7      29
   Phase Difference      mr    ±6283.2   Float          7      37
   Gains/Attenuator    ###A   ex:"026O"  Character      4      42
   SEM                   mr              Scaled         6      49
   Self Potential        mv              Scaled         7      57
   Contact Resistance     Ω              Scaled w/exp   6      64
   External Amp Gain      #   1 - 9      Integer        1      66
```

Sample GDP CSHA DATA BLOCK

```
0117
CSHA0530 92-10-21 16:29:15 12.1v AMT
Tx        1 Rx      850 N 60, 5
1024 Hz  16384 Cyc Tx Curr  28.0
1  Ex    600  495.99u  -206.8  244.9  016O   0.76  -22.71  7.62K 0
2  Ex    700  353.53u  -322.9  124.4  026O   0.93   45.39  9.04K 0
3  Ex    800  531.99u  -311.0  281.7  036O   0.55   29.21  5.10K 0
4  Ex    900  638.55u  -341.4  405.9  036O   0.51  -36.76  3.59K 0
5  Ex   1000  573.13u  -333.2  327.0  026O   0.49  -19.34  3.45K 0
6  Ex   1100  940.29u  -325.9  880.2  016O   0.40  -17.93  3.17K 0
7  Hy     590 14.522u -1259.9   933.9 026O   0.54   -7.03   441  0
   Rho 1  Rho 3  Rho 5  Rho 7  Rho 9     PD 1    PD 3    PD 5  ...
1  244.9  392.8  490.9  714.6  617.3   1053.1  1130.0  1142.6  ...
2  124.4  170.2  177.4  207.5  144.4    936.9   836.4   717.7  ...
3  281.7  385.2  414.8  528.2  600.6    948.8   912.6   851.3  ...
4  405.9  533.0  556.1  691.9  750.5    918.5   853.5   765.6  ...
5  327.0  432.3  431.1  488.2  506.1    926.6   876.4   804.6  ...
6  880.2  1.169K 1.177K 1.383K 1.451K   933.9   906.5   855.3  ...
Harmonics 1               3                5                7 ...
1  495.99u  -206.8  361.06u  -546.7  302.26u  -634.5  286.64u  ...
2  353.53u  -322.9  237.68u  -840.2  181.68u -1059.3  154.47u  ...
3  531.99u  -311.0  357.55u  -764.1  277.83u  -925.8  246.45u  ...
4  638.55u  -341.4  420.60u  -823.2  321.71u -1011.5  282.06u  ...
5  573.13u  -333.2  378.80u  -800.3  283.26u  -972.5  236.92u  ...
6  940.29u  -325.9  623.01u  -770.2  468.07u  -921.7  398.74u  ...
7  14.522u -1259.9  4.8197u -1676.7  2.7955u -1777.1  1.8571u  ...
```

NOTE: Harmonic Impedance Phase Data are shown through the 5th harmonic value. Harmonic Magnitude and Phase data are shown through the 7th harmonic magnitude.

CSHA input data file structure

Refer to RPIP for structure of lines 1 - 4.

Refer to CSAMT for structure of line 5 (channel measurements)

Structure of Resistivity and Impedance Phase lines. There will be one line for each E-field component.

-- FIELD_NAME -------	UNITS --	RANGE ---	TYPE ------	WIDTH --	END --
Channel Number	#	1 - 8	Integer	1	1
Resistivity 1	Ωm		Scaled w/exp	6	9
Resistivity 3	Ωm		Scaled w/exp	6	16
Resistivity 5	Ωm		Scaled w/exp	6	23
Resistivity 7	Ωm		Scaled w/exp	6	30
Resistivity 9	Ωm		Scaled w/exp	6	37
Impedance Phase 1	mr	±6283.2	Float	7	45
Impedance Phase 3	mr	±6283.2	Float	7	53
Impedance Phase 5	mr	±6283.2	Float	7	61
Impedance Phase 7	mr	±6283.2	Float	7	69
Impedance Phase 9	mr	±6283.2	Float	7	77

Refer to CR for structure of lines below the "Harmonics" label.

Sample GDP AMT DATA BLOCK

```
0487
AMT 0530 93-04-21 13:43:22 12.3v VEC
Tx        1 Rx        9 N 60, 5
  128 Hz     1 Bursts  9 Stacks  256 Samples      2      1
1  Ex      9  27.777m   0.852  19.50  226O      9    7.63   943  0
2  Hy      85 513.35u   584.2  26.83  206O      9  -11.04  55.0K 0
3  Ey      9  7.3566m   0.925  21.82  056O      8  -12.41   829  0
4  Hx      95 133.87u   877.8  25.51  016O      8  -16.77  54.9K 0
freq  ExMag   HyMag1 xyRho1 xyRho2   xyPhz    xyCC
 128 510.99u 16.997u 22.80  54.67    885.9   0.646
 256 995.88u 26.433u 23.94  32.11    829.5   0.863
 384 5.0054m 109.40u 23.48  31.64    494.2   0.861
 512 8.5127m 148.74u 28.31  36.15    879.4   0.885
 640 27.777m 513.35u 19.50  26.83    584.2   0.852
 768 29.257m 360.66u 33.41  54.94    387.2   0.780
 896 61.030m 586.20u 47.58  76.89    196.4   0.787
freq  EyMag   HxMag1 yxRho1 yxRho2   yxPhz    yxCC
 128 121.86u 6.4127u  9.19  21.64    293.6   0.652
 256 312.08u 6.7449u 35.26  49.58    487.0   0.843
 384 2.1014m 40.806u 32.24  36.99    653.1   0.934
 512 2.4406m 32.209u 50.63  62.10    591.2   0.903
 640 7.3566m 133.87u 21.82  25.51    877.8   0.925
 768 10.386m 136.75u 35.08  40.21    678.7   0.934
 896 13.585m 178.19u 24.21  43.46    771.3   0.746
```

AMT input data file structure

Refer to RPIP for structure of lines 1 - 3.

```
-- FIELD_NAME ------- UNITS -- RANGE --- TYPE ------ WIDTH -- END --
Line 4
     Frequency             Hz   ex:"   1"  Scaled         4       4
     Burst Count            #   0 - 50     Integer        3      14
     Stack Count            #   0 - 16384  Integer        5      24
     Sample Count           #   0 - 1024   Integer        4      36
     Good Ex Count          #   0 - 16384  Integer        6      51
     Good Ey Count          #   0 - 16384  Integer        6      58

-- FIELD_NAME ------- UNITS -- RANGE --- TYPE ------ WIDTH -- END --
Line 5, Ex channels
     Channel Number         #    1 - 8     Integer        2       2
     Skip Flag              -   sp,x,-,b   Character      1       3
     Channel Type           -   ex:"Ex"    Character      3       6
     Station Number         #  ±0 - 99999  Scaled         6      12
     Magnitude √autopower   v              Scaled w/exp   8      21
     Correlation            #   0 - 0.999  Float          7      29
     5h RhoA ExHy*/HyHy*   Ωm              Scaled w/exp   7      37
     Gains/Attenuator    ###A   ex:"016O"  Character      4      42
     Good Burst Count       #   0 - 16384  Integer        5      49
     Self Potential        mv              Scaled         7      57
     Contact Resistance     Ω              Scaled w/exp   6      64
     External Amp Gain      #   0 - 7      Integer        1      66
```

AMT input data file structure (cont'd)

Line 5, Hy channels					
Channel Number	#	1 - 8	Integer	2	2
Skip Flag	-	sp,x,-,b	Character	1	3
Channel Type	-	ex:"Hy"	Character	3	6
undefined	#		spaces	3	9
Antenna/Channel	#	0 - 9999	Integer	4	13
Magnitude √autopower	µTesla		Scaled w/exp	8	21
Phase	mr	±6283.2	Scaled	7	29
5h RhoA ExHy*/HyHy*	Ωm		Scaled w/exp	7	37
Gains/Attenuator	###A	ex:"026O"	Character	4	42
Good Burst Count	#	0 - 16384	Integer	5	49
Self Potential	mv		Scaled	7	57
Contact Resistance	Ω		Scaled w/exp	6	64
External Amp Gain	#	0 - 7	Integer	1	66

Structure of Magnitude, Resistivity, Impedance Phase and Tipper lines. For each harmonic frequency there is one line for sections ExHy & Hz and EyHx & Hz. Data are provided for harmonics 1, 2, 3, 4, 5, 6, 7.

The measurement sequence may result in multiple magnitudes for each H-field component. There may be different values for HyMag, one measured with the ExMag, and a second measured with HzMag.

-- FIELD_NAME -------	UNITS --	RANGE ---	TYPE ------	WIDTH --	END --
Frequency	Hz	ex:" 1"	Scaled	4	4
Ex or EyMagnitude	v		Scaled w/exp	7	12
Hy or HxMagnitude	µTesla		Scaled w/exp	7	20
xy or yxRho1	Ωm		Scaled w/exp	6	27
xy or yxRho2	Ωm		Scaled w/exp	6	34
xy or yxPhase	mr	±6283.2	Scaled	7	42
xy or yxCorrelation	#	0 - 0.999	Float	7	50
HzMagnitude	µTesla		Scaled w/exp	7	58
Hy or HzMagnitude	µTesla		Scaled w/exp	7	66
zy or zxTipper	#		Scaled w/exp	7	73
zy or zxPhase	mr	±6283.2	Scaled	7	81

Appendix B ... SHRED Data Record Structures

HEADER RECORD structure

FIELD_NAME	UNITS	RANGE	TYPE	WIDTH	END
Record Type	-	H , D	Character	1	1
Skip/Average Flag	#	0 , 1	Integer	1	3
Block Number	#	0 - 9999	Integer	4	8
Header Label	#	0 - 999	Integer	3	12
Sequence Number	#	0 - 9	Integer	1	14
Survey Type, Version	-		Character	8	23
Date	date	dd mmm yy	Date	8	32
Time	time	hh:mm:ss	Time	8	41
Voltage	v	0 - 99.9	Scaled	4	46
Array Type	-	ex:"D-D"	Character	3	50
Operator	-	ex:"JOHN"	Character	4	60
Tx Identification	-	ex:"ONE"	Character	4	65
A-Spacing	m	positive	Scaled	6	72
Job Number	-	ex:"GOLD"	Character	5	78
Line Number	-	ex:"1+00"	Character	8	87
Line Direction	-	ex:"NE"	Character	2	90
Spread	-	ex:"A"	Character	2	93

One of the following sections may be included after the end of the normal Header:

TDIP, RPIP, CR header addition

Tx Shunt	(CR or RPIP)	Ω	positive	Scaled w/exp	9	103
Ax	(Sch or Grd)	m	±0-9999999	Scaled	8	112
Bx	(Sch or Grd)	m	±0-9999999	Scaled	8	121

TEM header addition

Duty Cycle	%	50 or 100%	Character	3	97
Receiver Moment	m^2	1 - 999999	Integer	6	104
Tx Length, X	m	1 - 9999	Integer	4	109
Tx Length, Y	m	1 - 9999	Integer	4	114
Tx Loop Turns	#	1 - 99	Integer	2	117
Tx Turnoff Delay	s	1 - 9999	Scaled w/exp	7	125
Rx Antenna Delay	s	1 - 9999	Scaled w/exp	7	133
Coil Reference Factor	#	.001 - 9.999	Float	5	143

AMT header addition

Correlation Limit	#	0 - 0.999	Float	5	99
FFT Function	-	ex:"HANN"	Character	4	104

RPIP RECORD structure

FIELD_NAME	UNITS	RANGE	TYPE	WIDTH	END
Record Type	-	H , D	Character	1	1
Skip/Average Flag	#	0 , 1	Integer	1	3
Block Number	#	0 - 9999	Integer	4	8
Header Label	#	0 - 999	Integer	3	12
Sequence Number	#	0 - 9	Integer	1	14
Date	date	dd mmm yy	Character	8	23
Time	time	hh:mm:ss	Character	8	32
Voltage	v	0 - 99.9	Scaled	4	37
Frequency	Hz	ex:"8192"	Scaled	5	43
Cycles	#	1 - 16384	Integer	5	49
Tx Current	amps	0 - 99999	Scaled w/exp	8	58
Tx	#	±0-9999999	Integer	8	67
Rx Calculated	#	pos or neg	Scaled w/exp	11	79

Secondary structure

Channel Type	-	"ON","Ref"	Character	3	83
Polarity Flip Flag	#	0 , 1	Integer	1	85
N-Spacing	#	0 - 99.9	Scaled	8	94
Magnitude	v		Scaled w/exp	10	105
Phase	mr	±6283.2	Scaled w/exp	10	116
Resistivity	Ωm		Scaled w/exp	10	127
Gains/Attenuator	###A	ex:"000O"	Character	4	132
SEM	mr		Scaled	7	140
Self Potential	mv		Scaled	7	151
Contact Resistance	Ω		Scaled w/exp	9	161
External Amp Gain	#	1-999999	Integer	6	167

Reference channel magnitude (only when Reference channel in use)

Reference Magnitude	v		Scaled w/exp	10	178

CR RECORD structure

FIELD_NAME	UNITS	RANGE	TYPE	WIDTH	END
Record Type	-	H , D	Character	1	1
Skip/Average Flag	#	0 , 1	Integer	1	3
Block Number	#	0 - 9999	Integer	4	8
Header Label	#	0 - 999	Integer	3	12
Sequence Number	#	0 - 9	Integer	1	14
Date	date	dd mmm yy	Character	8	23
Time	time	hh:mm:ss	Character	8	32
Voltage	v	0 - 99.9	Scaled	4	37
Frequency	Hz	ex:" 8"	Scaled	5	43
Cycles	#	1 - 16384	Integer	5	49
Tx Current	amps	0 - 99999	Scaled w/exp	8	58
Tx	#	±0-9999999	Integer	8	67
Rx Calculated	#	pos or neg	Scaled w/exp	11	79

Secondary structure

Channel Type	-	ex:"Ex"	Character	3	83
Polarity Flip Flag	#	0 - 1	Integer	1	85
N-Spacing	#	0 - 99.9	Scaled	8	94
Magnitude	v		Scaled w/exp	10	105
3-Point DC Phase	mr	±6283.2	Scaled w/exp	10	116
Resistivity	Ωm		Scaled w/exp	10	127
Gains/Attenuator	###A	ex:"026O"	Character	4	132
SEM	mr		Scaled	7	140
Self Potential	mv		Scaled	7	151
Contact Resistance	Ω		Scaled w/exp	9	161
External Amp Gain	#	1-999999	Integer	6	167

Harmonic data structure

Magnitude 1	v		Scaled w/exp	10	178
Phase 1	mr	±6283.2	Float	7	186
Magnitude 3	v		Scaled w/exp	10	197
Phase 3	mr	±6283.2	Float	7	205
Magnitude 5	v		Scaled w/exp	10	216
Phase 5	mr	±6283.2	Float	7	224
Magnitude 7	v		Scaled w/exp	10	235
Phase 7	mr	±6283.2	Float	7	243
Magnitude 9	v		Scaled w/exp	10	254
Phase 9	mr	±6283.2	Float	7	262

Reference channel magnitude (only when Reference channel in use)

Reference Magnitude	v		Scaled w/exp	10	273

Laboratory Rock value structure (Array Type: LAB)

Shunt Resistor	Ω		Scaled w/exp	9	283
Rock Sample Length	cm		Scaled w/exp	9	293
Rock Sample Area	cm^2		Scaled w/exp	9	303

TDIP RECORD structure

FIELD_NAME	UNITS	RANGE	TYPE	WIDTH	END
Record Type	-	H , D	Character	1	1
Skip/Average Flag	#	0 , 1	Integer	1	3
Block Number	#	0 - 9999	Integer	4	8
Header Label	#	0 - 999	Integer	3	12
Sequence Number	#	0 - 9	Integer	1	14
Date	date	dd mmm yy	Character	8	23
Time	time	hh:mm:ss	Character	8	32
Voltage	v	0 - 99.9	Scaled	4	37
Frequency	Hz	ex:" 16"	Scaled	5	43
Cycles	#	1 - 16384	Integer	5	49
Tx Current	amps	0 - 99999	Scaled w/exp	8	58
Tx	#	±0-9999999	Integer	8	67
Rx Calculated	#	pos or neg	Scaled w/exp	11	79

Secondary structure

Channel Type	-	ex:"On"	Character	3	83
Polarity Flip Flag	#	0 , 1	Integer	1	85
N-Spacing	#	0 - 99.9	Scaled	8	94
Primary Voltage	v		Scaled w/exp	10	105
Chargeability	ms	±9999.9	Scaled w/exp	10	116
Resistivity	Ωm		Scaled w/exp	10	127
Gains/Attenuator	###A	ex:"026O"	Character	4	132
SEM	ms		Scaled	7	140
Self Potential	mv		Scaled	7	151
Contact Resistance	Ω		Scaled w/exp	9	161
External Amp Gain	#	1-999999	Integer	6	167

Window Data structure (13 values, total 271 columns)

Window Value	10*mV/V	±0-999999	Integer	7	+8

TEM RECORD structure

FIELD_NAME	UNITS	RANGE	TYPE	WIDTH	END
Record Type	-	H , D	Character	1	1
Skip/Average Flag	#	0 , 1	Integer	1	3
Block Number	#	0 - 9999	Integer	4	8
Header Label	#	0 - 999	Integer	3	12
Sequence Number	#	0 - 9	Integer	1	14
Date	date	dd mmm yy	Character	8	23
Time	time	hh:mm:ss	Character	8	32
Voltage	v	0 - 99.9	Scaled	4	37
Frequency	Hz	ex:" 1"	Scaled	5	43
Cycles	#	1 - 16384	Integer	5	49
Tx Current	amps	0 - 99999	Scaled w/exp	8	58
Tx	#	±0-9999999	Integer	8	67
Rx Calculated	#	pos or neg	Scaled w/exp	11	79

Secondary structure

Channel Type	-	ex:"Hz"	Character	3	83
Polarity Flip Flag	#	0 , 1	Integer	1	85
Station Number	#	0 - 99.9	Integer	8	94
Magnitude	v/a		Scaled w/exp	10	105
Window Number	#		Integer	10	116
Resistivity	Ωm		Scaled w/exp	10	127
Gains/Attenuator	###A	ex:"026O"	Character	4	132
SEM	v/a		Scaled w/exp	10	143
Self Potential	mv		Scaled	7	151
Contact Resistance	Ω		Scaled w/exp	9	161
External Amp Gain	#	1-999999	Integer	6	167

TEM Data structure

Sampling Delay	s		Scaled w/exp	9	177
Alias Delay	s		Scaled w/exp	7	185
Window 1 TIme	s		Scaled w/exp	9	195
Sampling Interval	s		Scaled w/exp	10	206
Mag/Rho Label	-	"Tm", "Tr"	Character	2	209

TEM Mag / Rho structure (22, 25, 28, 31 or 32 values, max 561 columns)

Window Value	v/a or Ωm		Scaled w/exp	10	+11

CSAMT RECORD structure

FIELD_NAME	UNITS	RANGE	TYPE	WIDTH	END
Record Type	-	H , D	Character	1	1
Skip/Average Flag	#	0 , 1	Integer	1	3
Block Number	#	0 - 9999	Integer	4	8
Header Label	#	0 - 999	Integer	3	12
Sequence Number	#	0 - 9	Integer	1	14
Date	date	dd mmm yy	Character	8	23
Time	time	hh:mm:ss	Character	8	32
Voltage	v	0 - 99.9	Scaled	4	37
Frequency	Hz	ex:"1024"	Scaled	5	43
Cycles	#	1 - 16384	Integer	5	49
Tx Current	amps	0 - 99999	Scaled w/exp	8	58
Tx	#	±0-9999999	Integer	8	67
Rx Calculated	#	pos or neg	Scaled w/exp	11	79

E-field structure

Channel Type	-	Ex,Ey,E-	Character	3	83
Polarity Flip Flag	#	0 , 1	Integer	1	85
Station #	#	±0 - 99999	Scaled	8	94
Magnitude	v		Scaled w/exp	10	105
Phase	mr	±6283.2	Scaled w/exp	10	116
Resistivity	Ωm		Scaled w/exp	10	127
Gains/Attenuator	###A	ex:"026O"	Character	4	132
SEM	mr		Scaled	7	140
Self Potential	mv		Scaled	7	151
Contact Resistance	Ω		Scaled w/exp	9	161
External Amp Gain	#	1-999999	Integer	6	167

H-field structure

Channel Type	-	Hx,Hy,Hz,H-	Character	3	171
Polarity Flip Flag	#	0 , 1	Integer	1	173
Antenna/Channel	#	0 - 9999	Integer	4	182
Magnitude	µTesla		Scaled w/exp	10	193
Phase	mr	±6283.2	Scaled w/exp	10	204
Phase Difference	mr	±6283.2	Float	10	215
Gains/Attenuator	###A	ex:"026O"	Character	4	220
SEM	mr		Scaled	7	228
Self Potential	mv		Scaled	7	239
Contact Resistance	Ω		Scaled w/exp	9	249
External Amp Gain	#	1-999999	Integer	6	255

CSHA RECORD structure

CSHA data structure is identical to the CSAMT data structure. The data are separated by frequency, and written using the same format.

AMT RECORD structure

FIELD_NAME	UNITS	RANGE	TYPE	WIDTH	END
Record Type	-	H , D	Character	1	1
Skip/Average Flag	#	0 , 1	Integer	1	3
Block Number	#	0 - 9999	Integer	4	8
Header Label	#	0 - 999	Integer	3	12
Sequence Number	#	0 - 9	Integer	1	14
Date	date	dd mmm yy	Character	8	23
Time	time	hh:mm:ss	Character	8	32
Voltage	v	0 - 99.9	Scaled	4	37
Frequency	Hz	ex:"1024"	Scaled	5	43
Burst count	#	1 - 15	Integer	5	49
Tx Current	constant	0.00	Character	8	58
Tx	#	±0-9999999	Integer	8	67
Rx Calculated	#	pos or neg	Scaled w/exp	11	79

Ex,Ey,(E-) channel structure

Channel Type	-	Ex,Ey,E-	Character	3	83
Polarity Flip Flag	#	0 , 1	Integer	1	85
Station #	#	±0 - 99999	Scaled	8	94
E- Magnitude	v		Scaled w/exp	10	105
Correlation Coeff.	#	0 - 0.999	Float	10	116
Resistivity 1	Ωm		Scaled w/exp	10	127
Gains/Attenuator	###A	ex:"026O"	Character	4	132
Good Burst Count	#	0 - 16384	Integer	7	140
Self Potential	mv		Scaled	7	151
Contact Resistance	Ω		Scaled w/exp	9	161
External Amp Gain	#	1-999999	Integer	6	167

Hx,Hy,(Hz) channel structure

Channel Type	-	Hx,Hy,Hz,H-	Character	3	171
Polarity Flip Flag	#	0 , 1	Integer	1	173
Antenna/Channel	#	0 - 9999	Integer	4	182
zy Hz Magnitude	µTesla		Scaled w/exp	10	193
Phase	mr	±6283.2	Scaled w/exp	10	204
Resistivity 2	Ωm		Scaled w/exp	10	215
Gains/Attenuator	###A	ex:"026O"	Character	4	220
Good Burst Count	#	0 - 15	Integer	7	228
Self Potential	mv		Scaled	7	239
Contact Resistance	Ω		Scaled w/exp	9	249
External Amp Gain	#	1-999999	Integer	6	255

Additional parameters

Stack Count	#	0 - 50	Integer	3	259
Samples per Burst	#	0 - 1024	Integer	4	264
zx Hz Magnitude	µTesla		Scaled w/exp	10	275

E-,Hz channel structure Same as above except as noted here.

Default Magnitude	v	0	Scaled w/exp	10	105
zx Phase Difference	mr	±6283.2	Scaled w/exp	10	116
zx ratio, Tipper	#		Scaled w/exp	10	127
Default Stack Count	#	0	Integer	7	140
Default Self Potential	#	0	Scaled	7	151
Default Contact Res.	#	0	Scaled w/exp	9	161
External Amp Gain	#	1-999999	Integer	6	167
zy Phase Difference	mr	±6283.2	Scaled w/exp	10	204
zy ratio, Tipper	#		Scaled w/exp	10	215
Default Stack Count	#	0	Integer	7	228

Appendix C ... GDP Calibrate Data Structures

Measured data are decalibrated by:

1. divide by calibrate magnitude values, and
2. subtract calibrate phase values (no phase values for Time Domain)

NON-HARMONIC CALIBRATE STRUCTURES

Frequency labels defined:

.001	.002	.004	.008	.016	.031	.063	.125	.250	.500	1	2
4	8	16	32	64	128	256	512	1024	2048	4096	8192

TDCAL structure: TEM, TDIP system

CAL 8192	
1	1.00000
2	1.00000
3	1.00000
4	1.00000
5	1.00000
6	1.00000
7	1.00000
8	1.00000
9	1.00000
10	1.00000
11	1.00000
12	1.00000
13	1.00000
14	1.00000
15	1.00000
16	1.00000

FDCAL structure: RPIP, CSAMT system

CAL 8192		
1	.14427	975.7
2	.14102	975.6
3	.13454	948.8
4	.13433	978.4
5	.13730	972.0
6	.14443	996.3
7	.13780	948.9
8	.14244	980.2
9	1.00000	0.0
10	1.00000	0.0
11	1.00000	0.0
12	1.00000	0.0
13	1.00000	0.0
14	1.00000	0.0
15	1.00000	0.0
16	1.00000	0.0

ANTCAL structure: CSAMT coil

ANTENNA 8192		
010	138.15000	-796.2
020	137.45000	-511.8
030	142.61000	-752.1
250	107.86000	-665.3
151	19.95000	-1729.5
152	20.44200	-1703.2
161	23.34900	-1716.9
490	111.02000	-555.2
0	1.00000	0.0
0	1.00000	0.0
0	1.00000	0.0
0	1.00000	0.0
0	1.00000	0.0
0	1.00000	0.0
0	1.00000	0.0
0	1.00000	0.0

TDCAL : channel number and magnitude data (no phase data)
FDCAL : channel number, magnitude and phase data.
ANTCAL: coil number and channel, magnitude and phase data.

Calibrate values are not restricted to specific columns, but must be separated by one or more spaces.

HARMONIC CALIBRATE STRUCTURES

Frequency labels defined:

```
                        .016  .031  .063  .125  .250  .500     1     2
   4     8    16    32    64   128   256   512  1024  2048
```

CRCAL structure: (CR, CSHA system calibrate)

```
CR 2048
 1    .94340  1780.2      .21253  2890.0      .04791 -2474.1  ...
 2    .93949  1796.2      .20745  2910.0      .04643 -2465.7  ...
 3    .94000  1806.5      .20583  2932.8      .04550 -2435.3  ...
 4    .93655  1806.3      .20225  2933.5      .04443 -2451.8  ...
 5    .93688  1798.3      .20614  2917.1      .04571 -2458.4  ...
 6    .93948  1791.3      .20889  2894.8      .04685 -2487.9  ...
 7    .93862  1806.2      .20504  2933.5      .04552 -2438.6  ...
 8    .93796  1796.0      .20579  2912.9      .04596 -2469.8  ...
 9   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
10   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
11   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
12   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
13   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
14   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
15   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
16   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
```

HACAL structure: (CR, CSHA H-field coil calibrate)

```
HA 2048
  570 111.89372   168.2   116.60997   -85.3   112.94829  -231.2  ...
  133  67.57783  1461.1   205.75810  1236.0   366.97522   958.2  ...
   30 155.95605   288.2   164.83627  -116.6   155.72630  -331.3  ...
  250 115.76102   154.2   118.69548  -127.7   112.69119  -291.6  ...
  490 111.44049   171.8   116.44593   -74.1   113.46755  -213.8  ...
  103  68.10265  1465.1   208.69449  1237.0   368.79691   947.6  ...
  113  67.86490  1460.4   207.54478  1222.6   364.73868   926.4  ...
  123  67.95684  1461.2   208.03650  1224.7   366.10318   928.5  ...
    0   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
    0   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
    0   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
    0   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
    0   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
    0   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
    0   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
    0   1.00000     0.0     1.00000     0.0     1.00000     0.0  ...
```

CRCAL: channel number, magnitude and phase data for five harmonics.
HACAL: coil number and channel, mag and phase data for 5 harmonics.

The GDP-16 provides up to 8 channels, and 16 channels for the GDP-32.

Calibrate values are not restricted to specific columns, but must be separated by one or more spaces. In the above samples, the fifth and seventh magnitude and phase values are not included.

System calibrate magnitude values are unitless.
Coil calibrate magnitude values use units of milliVolts/nanoTesla.
Calibrate phase values use units of milliRadians.

Appendix D ... File Format Changes

GDP-16 .RAW-file, version 5.21

Additions
Header block inventory includes measured Gain Factors.

Ax location is an 8 char padded field (7 digits and sign)
Bx location is an 8 char padded field (7 digits and sign)
Ax and Bx appear in header block after SPREAD when Array Type is "Sch" or "Grd".

Changes
LINE increased from 6 to 8 chars.
Added a digit and allow negative sign (shifts SPREAD by 2 chars).

Header block inventory S/N increased from 3 to 4 digits.

When Array Type is "Grd", the "Tx" label is "Ry".

"Tx" and "Rx" are 8 char padded fields (7 digits and sign).
(shifts "Rx" by 2 chars, shifts "N" by another 2 chars)

"Tx Curr" format provides a floating decimal point, 0 to 3 digits.
(no shift to any following fields, such as TEM delay times)
(still restricted to positive values)

"A-Spacing" format provides a floating decimal point, 0 to 4 digits.
(no shift to any following fields, such as SHUNT)
(still restricted to positive values)

TDIP window magnitude format is an 8 char padded field
(7 digits and sign). (increase of 3 characters)

TDIP window magnitude format adds one char of precision:
from milliunits to milliunits x10.

TEM may include up to 31 windows (increase from 28)

SHRED .FLD-file, version 2.60

Additions
Ax and Bx after Shunt in Header record.

Changes
Calculated Rx field increased from 10 to 12 characters.
N-Spacing field increased from 7 to 8 characters.
Scaling for TEM TxDelay and AntDelay changed from µs to seconds.

SHRED .FLD-file, version 2.8x

Additions
Natural Source AMT included. Provide for seven harmonics.
Compare A-Spacing by value instead of by character string.

Include coherency limit for AMT data: $ SHRED: CL= 0.400.
Data that is below the limit will not be included in the .FLD-file.

Changes
TDIP setups now separate data by frequency, as for TEM. See the section "Sorting the data file".

For CR data with no E-fields (and no available station labels), use the coil number in the station field instead of a default (1.0) value.

Provide for variable decimal location for current (amps) value.

To Come
CSAMT H-field structure needs Phase Difference field expanded by three characters to provide for scaled value. The AMT structure uses the same format, and includes scaled values in this field.

Compatibility with GDP-16 and GDP-32 data formats. The Ch# (channel number) and TEM RxM (Rx Moment) fields will increase by one character.

SHRED .RAW-file, version 3.0x

Additions
Add one character to channel number field to provide for 16 channel GDP-32 data.

Expand TEM RxM (Receiver moment) value limit from 99999 to 999999.

SHRED .FLD-file, version 3.0x

Additions
Provide for GDP-16 and GDP-32 data formats up to version 0530.

Changes
Expand TEM RxM (Receiver moment) value limit from 99999 to 999999.

To Come
Provide 16 channel calibrate buffers, presently limited to 8 channels.
Calculate NSAMT calibrate data for even harmonics.
Provide initial support for alphanumeric fields (operator and line).

Provide error message when recalculating station/n-spacing for a setup and the scale changes. (as when improperly adding a shallow channel)

GDP .RAW-file, AMT 0526

Additions

Add 2 character external preamp gain (exponent of two) after Contact Resistance.

```
 0239
 AMT 0526 93-04-12 17:58:48 12.3v SCA
 Tx        1 Rx        3 N 60, 5
     8 Hz    15 Bursts  1 Stack   256 Samples      1      0
 1  Ex      1  8.6697u   0.954  21.81  245O     15    0.26     0  3
 2  Ex      2  7.4002u   0.756  12.60  244O     15    0.26     0  3
 3  Hy      24 2.1014u   718.4  18.69  062O     15    0.69     0  0
```

GDP .RAW-file, AMT 0530

Changes

Change OPER	from 4 digit integer	to 9 character alphanumeric value.
Change LINE	from 9 digit scaled value	to 8 character alphanumeric value.
Change SPREAD	from 2 digit integer	to 2 character alphanumeric value.
Change TX-ID	from 4 digit integer	to 4 character alphanumeric value.
Change JOB	from 5 digit integer	to 5 character alphanumeric value.

Note: Gradient and Schlumberger arrays require numeric LINE value.

Change the TEM Reference Window number to a Reference Window time.
SHRED will not recognize the custom TDCS program type.

To Come

Add Rx and Ry channel types for remote reference applications.
Change External Amp Gain to decimal instead of log base two.
Multiple Ex and Ey components for vector applications.
Add cascade decimation data acquisition. Will add a field, but not change formats.

SHRED .FLD-file, version 3.2x

Additions

Provide for GDP-16 and GDP-32 data formats including version 0530.
Add sampling interval to TEM records, after Alias Filter Delay.

Add external amp gain, 5-digit integer following contact resistance, for all components. The GDP .RAW-file value is an exponent of two, the .FLD-file value is the actual value.

Changes

Increase OPER field from 4 to 9 characters.
Exchange the AMT program fields for Stacks and Bursts.

For CR data with no E-fields (and no available station labels), use the Rx value instead of the coil number or a default (1.0) value.
For all component records, expand the phase value field by three characters to allow for scaled values.

The following default values are provided for older data file formats.
Default values are zero for Sample Delay, Alias Filter Delay, Sample Period.
Default values are one for Shunt, Rock Length, Rock Area.