12. TRANSIENT ELECTROMAGNETICS PROGRAM

12.1 INTRODUCTION

The transient electromagnetics or TEM program is a versatile electromagnetics program using standard phase-lock stacking and averaging methods for signal-to-noise enhancement.

The standard frequency range (repetition rate) of the TEM program is from 0.0625 (16 second period) to 32 Hz (0.03125 second period). The sample rate and window centers are controlled by changing the frequency or pulse repetition rate.

Windows acquired at various repetition rates are as follows:

Frequency (Repetition Rate)	WINDOWS					
		50% Duty Cycle			100% Duty Cycle	
	Nr.	First	Last	Nr.	First	Last
32 Hz	22	30.5 µs	6.07 ms	25	30.5 µs	12.1 ms
16 Hz	25	30.5 µs	12.1 ms	28	30.5 µs	24.2 ms
8 Hz	28	30.5 µs	24.2 ms	34	30.5 µs	48.4 ms
4 Hz	31	30.5 µs	48.4 ms	34	30.5 µs	96.7 ms
2 Hz	31	61.0 µs	96.7 ms	34	122.1 µs	193.5 ms
1 Hz	31	122.1 µs	193.5 ms	34	244.1 µs	387.0 ms
0.5 Hz	31	244.1 µs	387.0 ms	34	488.3 µs	773.9 ms
0.25 Hz	31	488.3 µs	773.9 ms	34	976.6 µs	1,548 ms
0.125 Hz	31	976.6 µs	1,548 ms	34	1.953 ms	3,096 ms
0.0625 Hz	31	1.953 ms	3,096 ms	34	3.906 ms	6,191 ms

Note: The default value for the first window will always be equal to or greater than the value shown above (e.g., 30.5 µs for 32 Hz) and less than two times that amount. See **Section 12.14** *and* **Section 12.7, Delays**.

A magnitude calibrate buffer, labeled `Time Domain Cal`, is included in the main data cache.

All versions have a digital telluric filter, which we call a moving average or MAV filter, for rejection of low frequency tellurics. This filter is active for 0.5 Hz and below.

This version of the program permits the use of a maximum of three analog channels for repetition rates of 4 through 32 Hz, and up to eight analog channels for repetition rates of 2 Hz or lower.

Go to *GDP Section 6* for information concerning calibration, synchronization and generic operation of all programs.

Go to the end of this TEM program manual for suggestions on connecting the receiver for field measurements.

12.2   FIXED FUNCTION KEYS
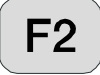
One of the differences between the GDP-32^{II} and its predecessor, the GDP-32, is the addition of

six fixed-function keys located below the six soft function keys (**F1** through **F6**) at the bottom edge of the LCD.

These keys are activated with the same menus as before, and are denoted as follows, from left to right:

DATA F7   By pressing this key you enter the field data cache and can view data, escape back to other menus to initialize or view other data caches, or output data to a PC from the data caches. See *DATA Section 7* for more details.

EXIT F8   Exit the data taking routine and return to the main menu for selection of other

programs by pressing **F2** . When exiting the program at this point, the main

menu will display **Back** above the **F2** function key to enable the operator to return to the **TEM** program, if desired.

CAL F9   Press this key to enter the calibrate and system checking program. See *GDP Section 6.1, Calibration* for more details.

GAIN F10   Press this key to enter the automatic or manual gain setting and SP buckout menu.

Note: G0 is not enabled for the TEM programs, but can be turned on manually by entering the GAIN program.

SP F11   Pressing this key will automatically buck out any self potential (SP) or amplifier offset, for any channel that is turned on.

CRES F12   Press this key to measure the contact resistance or coil output resistance. See *GDP Section 6.3, Measuring Contact Resistance* for more details.

12.3 TEM PROGRAM OPERATION

MENU 1:

In all of the following menu descriptions, the bold fields in the boxes are the parameters that can be changed by the operator.

Display screen with regular analog cards installed:

```
        TEM 0539              15 Mar 98 08:53:40


Array type: In-loop
Duty cycle:  50%  Window: Zonge Standard
Receiver moment:  10000
Transmitter X, Y:    1     1  Turns:  1
Tx Delay    50  Antenna Delay   15
Transmitter Type  GGT Series
Robust Filter: none
Gain Mode: Standard          Units:Meters
Alias : IN



 CONTINUE: Next menu, ESCAPE: Prev. menu
     Data
```

F1	F2	F3	F4	F5	F6
DATA F7	EXIT F8	CAL F9	GAIN F10	SP F11	CRES F12

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Display screen with both regular analog cards and NanoTEM cards installed:

```
        TEM 0539              15 Mar 98 08:53:40

Program: NanoTEM    Sample Rate: 1.2usec
Array type: In-loop
Duty cycle:  50%  Window: Zonge Standard
Receiver moment:   250
Transmitter X, Y:   20     20 Turns:  1
Tx Delay   1.5  Antenna Delay   2
Transmitter Type   ZT-20
Robust Filter: None
Gain Mode: Standard          Units:Meters
Alias : IN



 CONTINUE: Next menu, ESCAPE: Prev. menu
     Data
```

F1	F2	F3	F4	F5	F6
DATA F7	EXIT F8	CAL F9	GAIN F10	SP F11	CRES F12

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The ⟨**DATA F7**⟩ function key is active.

TEM 0539.   Program name and version.

15 Mar 98.   Date.

08:53:40.   Time.

Program: This line shows up on the menu only when a high speed NanoTEM card is installed, and the NanoTEM program is selected. The two selections are:

ZeroTEM   **TEM**   Standard 30.5 µs sample time for 4 through 32 Hz rep rates

NanoTEM   **NANO**   1.2 or 1.6 µs sample time TEM. See ***Section 12.18***.

Sample Rate: This line is displayed in the menu only when the NanoTEM program has been selected. The operator can choose between 1.2 and 1.6 microsecond sample rate.

Array type: Five types of arrays are selectable with the ⟨**SELECT UP** Home⟩ or ⟨**SELECT DN** End⟩ keys. (See ***Section 12.13, Arrays***):

In Loop   **INL**

Fixed Loop   **FXL**

Moving Loop   **MVL**

LOTEM   **LOT**

Coincident Loop   **COL**

Continuous   **CNT**

The three letter designators are the mode labels added to the data storage listings. The coincident loop, in loop (central loop), moving loop and fixed loop (moving receiver) systems are configured for a loop transmitter and receiver. The LOTEM type survey is usually run with a large dipole transmitter and a loop or combined loop and dipole receiver setup.

In Loop and **Coincident Loop**   arrays are used mainly for vertical sounding applications. Resistivities are calculated for Hz channels.

Fixed Loop   is used for profiling, and **Moving Loop** is used for both profiling and vertical sounding. Resistivities are not calculated for these configurations.

LOTEM,   or large offset TEM, is a method that uses a grounded current dipole for the transmitter (rather than a loop) and gathers magnetic field (and occasionally electric field) data with a large separation between the transmitter and receiver. It is included here mainly as a label for data acquisition. Resistivities are not calculated.

Continuous mode   is an experimental program developed for continuous logging for surface, downhole, underwater and airborne applications. Once started, the program will continue to acquire data continuously, in bursts specified by the number of cycles in Menu 4, until the ⟨**STOP AVG** Escape⟩ key is pressed.

Duty cycle.   Two different TEM options are accessed in Menu 1:

50%   (default): bipolar 1/4 period on, 1/4 period off, standard time domain waveform.

100%   Frequency domain waveform for LOTEM and experimentation.

Windows.   Three choices are available:

Zonge Standard: logarithmic window spacings as shown in *Sections 12.8 and 12.9* for TEM and *Sections 12.23.1* and *12.23.2* for NanoTEM

Shallow: higher density early time window spacing for NanoTEM only. See *Section 12.23.3*.

Equal Interval: data are acquired on an evenly spaced time sample and stored on disk. The first 31 samples are also stored in the data cache. See *Section 12.16*.

Receiver Moment.   Receiver antenna moment in square meters. The default value is 10,000 m^2, which is the moment of the TEM/3 antenna.

Note: The NanoTEM boards have an extra gain of 10 installed, so the equivalent area for the receiver moment is 10 times the physical size. For example, a 5 x 5 meter receiver loop would have a moment of 25 x 10, and the value input for the Receiver Moment would be 250.

Transmitter X, Y. Dimensions of the transmitter loop (or dipole) in meters.

Turns.   Number of turns in the transmitter loop. Default is 1.

Tx Delay.   Turnoff time of the transmitter, in microseconds.

Antenna Delay.   Inherent delay of the receiver coil and filters, in microseconds. The RVR and TEM/3 coils have delays of approximately 15 microseconds.

Transmitter Type. The options here are GGT Series, NT-20, or NT-32 (for the embedded Tx version). Specifying the NT-20 transmitter permits the receiver to control the transmitter - turning it on for data acquisition and off after acquisition - thus extending the battery life.

Robust Filter.   This filter was added at the request of several clients, and has 3 options:

None: standard linear (mean) stacking and averaging.

Median: median averaging

Trimmed mean: mean calculation after rejecting a percentage of the outliers. The rejection limits are selectable between +/- 12.5%, 25% and 37.5%.

Note: Field tests have determined that the best averaging method in the presence of powerline noise is standard linear mean averaging.

Gain Mode.   The default mode is **Standard**, which adjusts the gains for a maximum voltage of 2.5 Volts.   The other option is **Noisy**, which limits the gains to obtain a maximum voltage of 1.0 Volts. See *GDP Section 6.5, Gains*.

Units.   The operator can select meters or feet. The default is **meters**.

Alias.   The operator can lock the antialias filter out - for experimental use only. The antialias filter should always be **IN** for normal operation.

MENU 2:

```
      TEM 0539              15 Mar 98 08:53:45

OPER  JOHN.DOE TX ID    1  A-SP    100
JOB 94001 LINE       1  N  SPREAD  1




CONTINUE: Next menu, ESCAPE: Prev. menu
```

GDP-32 II MULTI-FUNCTION RECEIVER

F1	F2	F3	F4	F5	F6
DATA F7	EXIT F8	CAL F9	GAIN F10	SP F11	CRES F12

cρ **ZONGE ENGINEERING & RESEARCH ORGANIZATION, INC.**
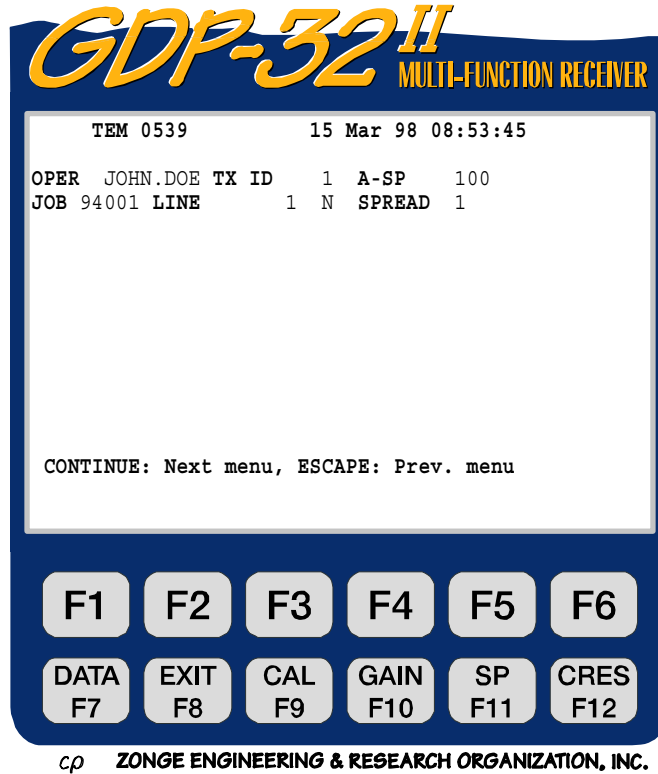
The **DATA F7** function key is active.

OPER. User defined identification. Alphanumerics permitted.

TX ID. User defined identification. Alphanumerics permitted.

A-SP. E-field dipole size in meters. Used only for LOTEM.
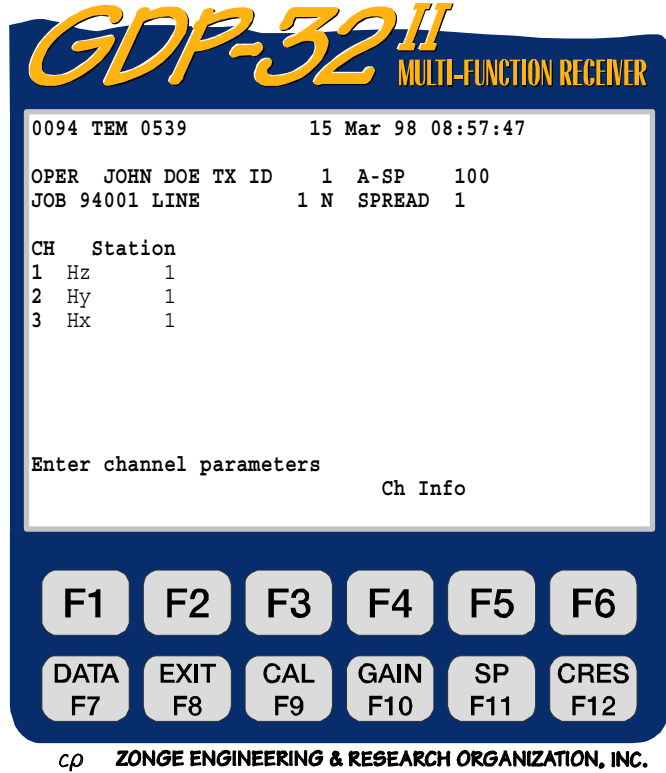
JOB. User defined identification number.

LINE. Two fields available: **xxxxxxx** defines the line number and **N, E, S, W,**

NE, SE, SW, NW designators are available by using the **SELECT UP Home** and **SELECT DN End** keys.

SPREAD. User defined identification number, subdivision of the **LINE** designator above.

MENU 3:

For this example we will assume a 3-axis measurement at a single station.

```
0094 TEM 0539            15 Mar 98 08:57:47

OPER  JOHN DOE TX ID   1  A-SP    100
JOB 94001 LINE         1 N  SPREAD  1

CH   Station
1  Hz      1
2  Hy      1
3  Hx      1




Enter channel parameters
                         Ch Info
```

The [DATA F7] function key is active.

CH. Selections are Hx, Hy, Hz, Ex, Ey, Ez, Ref and OFF. Resistivities are calculated for Hz channels only, when using the in-loop or coincident loop configuration. The total number of channels are presently limited to 3 for sample rates of 4 through 32 Hz. Eight channels can be used for sample rates of 2 Hz and below.

F1 F2 F3 F4 F5 F6
DATA F7   EXIT F8   CAL F9   GAIN F10   SP F11   CRES F12

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CAUTION - Channels must be turned on in sequence. For single channel operation use channel 1; for two channel operation use channels 1 and 2, etc. Turning on channel 2 only for single channel operation is not valid.

Station. Station identifier, used mostly for multiple station surveys.

Ch Info. Press [F5] for data on the analog cards that have passed QC. For example:

```
1 DiffAmp   Notch+60,3-5,9  S/N    67 Passed
2 DiffAmp   Notch+60,3-5,9  S/N   127 Passed
3 DiffAmp   Notch+60,3-5,9  S/N   256 Passed
```

Here **DiffAmp** indicates the input plug-in card is a differential amplifier, the powerline notch filter is a 60/180/300/540 Hz filter, (the "**+**" indicates a modification level), and the three board serial numbers are 67, 127, and 256.

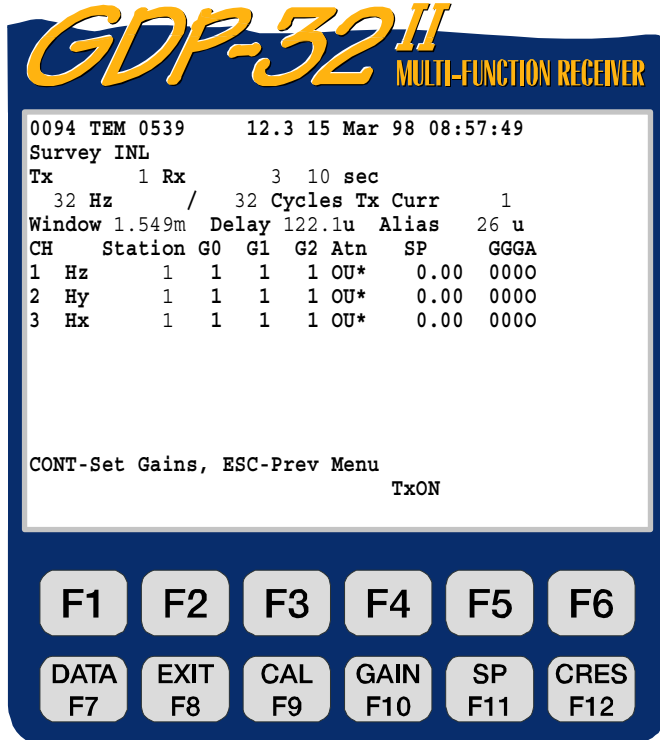If NanoTEM cards are installed, an example would be:

```
4 NanoTEM  A/D    1.2usec   S/N    31 Passed
5 NanoTEM  A/D    1.2usec   S/N    42 Passed
```

Note that a number (0094) is visible before the program designator (**TEM 0539**). This number is the label of the last data block written to the data cache. The next time a block of data is written to the cache, it will be numbered 0095.

MENU 4:

Upon pressing [CONTINUE Enter] after the parameters are set up in Menu 3, the following screen will be displayed. This is a combination of Menu 3 and Menu 4.

```
0094 TEM 0539    12.3 15 Mar 98 08:57:49
Survey INL
Tx      1 Rx      3  10 sec
  32 Hz      /   32 Cycles Tx Curr    1
Window 1.549m  Delay 122.1u  Alias   26 u
CH    Station G0  G1  G2 Atn   SP     GGGA
1  Hz      1   1   1   1 OU*   0.00  0000
2  Hy      1   1   1   1 OU*   0.00  0000
3  Hx      1   1   1   1 OU*   0.00  0000




CONT-Set Gains, ESC-Prev Menu
                        TxON
```

← We have selected the **In-Loop** array

← 10 sec indicates that sampling will occur every 10 seconds in Continuous mode. Not displayed for other configurations

[F1] [F2] [F3] [F4] [F5] [F6]

[DATA F7] [EXIT F8] [CAL F9] [GAIN F10] [SP F11] [CRES F12]

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All function keys are active: [DATA F7], [EXIT F8], [CAL F9], [GAIN F10], [SP F11], [CRES F12].

Tx. Transmitter location. The field for Tx designation is **±NNNNNNN** with a floating decimal point. Used for bookkeeping purposes in TEM.

Rx. Receiver location. The field for Rx is **±NNNNNNN** with a floating decimal point. Used for bookkeeping purposes in TEM.

Note: *The powerline notch filter switch is DISABLED for TEM.*

10 sec. If **Continuous** mode is selected, this field controls the sample interval. Here sampling will take place every 10 seconds, and 32 cycles of 32 Hz data will be acquired every 10 seconds. The operator must be careful to make sure that the sampling interval is large enough or the number of cycles are small enough so that all of the cycles can be obtained in the interval specified.

Hz. Frequency or repetition rate selection - use [SELECT UP Home] or [SELECT DN End] to change. Changes both repetition rate and sample rate according to the chart in *Section 12.7*.

Cycle.   Specify the number of cycles to average. Increments are in binary steps from 1 to 16,384. Use [SELECT UP Home] or [SELECT DN End] to change. As the system acquires data, the cycle count will be updated in real-time to the left of the number input by the operator.

Tx Curr. Transmitter current in amperes.

Window. The default is window number 16, which in this case occurs at 1.549 ms, for the given transmitter turnoff time, antenna delay, and alias filter delay. This window is monitored for run-time statistics and is user-selectable. Window center times are defined as the time interval occurring after the turnoff of the transmitter current (Tx current is zero).

Delay.   Delay in sampling to allow for turnoff time of the transmitter and delays in the antenna and anti-alias filter.

Delay increments are in multiples of the sample period. In this example, using a 32 Hz repetition rate, the sample period is 30.5 µs. The default program adjusts the delay time so that the first window is at least one sample period after transmitter turnoff (loop current equals zero amps). Hence in the Menu 4 example above, using default values of 50 µseconds delay for the transmitter to turnoff, 15 µsec for the antenna delay and 26 µsec for the anti-alias filter delay, we have a total delay of 91 µsec. Now add 30.5 µsec to that for one sample period for a total of 121.5 µsec. This means that we want the first sample (first window) to occur at least 121.5 µsec after the beginning of the turnoff ramp.

If we delay 4 sample periods (4 times 30.5 µs) the first window will occur 122.6 µsec after the beginning of transmitter turnoff ramp, and 31.6 µsec (122.6 - 91) after the end of the ramp. Thus, the first window will occur at 31.6 µsec in the data printout.

The delay time can be user adjusted for various tests and for measuring the complete transient during transmitter turnoff.

See *Section 12.14* for a graphic display of the combination of turnoff time and delays.

Alias.   The antialias filter delay is fixed by the corner frequency and is displayed for the operator's convenience. See *Section 12.7*.

Station. Station number. Can be accessed in either Menu 3 or 4 for ease in changing values during a survey. Our data processing programs sort first on **Station**, second on **Rx** and third on **Tx**.

TxON.   If the **Transmitter Type** is set to NT-20 in Menu 1, and the transmitter is being controlled by the receiver, the transmitter will be automatically turned on and off by the program when acquiring data. The [F5] key gives the operator manual control for checking gains, etc. If the label above [F5] is **TxON**, pressing [F5] will turn the transmitter **ON**; if it is labeled **TxOFF** pressing [F5] will turn the transmitter **OFF**. Any operator keystroke will be overridden by the program during data acquisition.

If the Transmitter Type is set to **GGT series**, the display above **F5** will be blank, and the operator will not have control of the transmitter off/on states.

G0, G1, G2. Gain stages 0, 1 and 2. Initially all gain stages are set to unity gain. Upon pressing **CONTINUE Enter**, the program will automatically set the gains and SP buckout if the auto-gain mode is selected as denoted by the message at the bottom of the screen: **CONT-Set gains, ESCAPE-Prev menu**. (This is the default mode).

Atn. The attenuator is bypassed (set to OUT) and fixed in the OUT position, as indicated by OU*. This is the default setting, since it is not advisable to use the attenuator in the TEM mode.

SP. Self Potential or offset in millivolts. Initially set to 0.00. Will be set to the actual value upon pressing **CONTINUE Enter**.

GGGA. Gain settings for stages 0, 1 and 2 (in powers of 2). The attenuator setting is **A**, **I** for **IN** and **O** for **OUT**.

NOTE: Some values are not registered in the computer memory until you exit the parameter field by pressing **PREV FIELD Pg Up**, **NEXT FIELD Pg Dn**, *or* **CONTINUE Enter**. *An exception to this rule is the Hz (frequency) field. Whenever you change the frequency it is automatically changed through the timing card. However, the anti-alias filter is not changed until just prior to data acquisition. Upon pressing continue to gather data, the computer will automatically set the anti-alias filter as defined by internal look-up tables.*

Notice also that the battery voltage (12.3) has now been inserted between the program version number and the date.

12.4   POWERLINE NOISE REJECTION

Field tests have demonstrated that in general the new binary crystals (4.980736 MHz) provide superior powerline noise rejection over the original 5 MHz crystals. The new crystals provide an exact binary frequency range so that stacking and averaging can be synchronous with the powerline frequencies.

Following are the test results for the old (5 MHz) crystals for various repetition rates (frequencies):

	50 Hz		60 Hz
Freq	Rejection	Freq	Rejection
32 Hz	2000:1	32 Hz	2000:1
16	140:1	16	700:1
8	250:1	8	20:1
4	250:1	4	50:1
2	80:1	2	700:1
1	250:1	1	333:1

For the new (4.980736 MHz) crystals:

	50 Hz		60 Hz
Freq	Rejection	Freq	Rejection
32,16, 8,4,1 Hz	10,000:1	32,16, 8,2,1 Hz	10,000:1
2 Hz	NONE	4 Hz	NONE

With the new crystals (4.980736 MHz), the powerline rejection is nominally greater than 10,000:1 for all frequencies *EXCEPT 2 Hz for 50 Hz noise and 4 Hz for 60 Hz noise*.

Note: The 2 Hz repetition rate should not be used around 50 Hz power systems, and 4 Hz should not be used when you have 60 Hz power systems. There is no effective rejection for these two repetition rates.

12.5 GATHERING DATA

Upon pressing **CONTINUE / Enter** after the parameters are set up in Menu 4 the following screen display is an example of what you will see with a signal connected to channels 1, 2 & 3. The battery voltage is measured and the A/D converter is automatically calibrated before each measurement cycle.

For this example we will set the frequency to 32 Hz, set the number of cycles to acquire to 128, Transmitter current to 1 amp, and leave the rest of the parameters with the default values. The signal source for this example is an RC network driven by an NT-20 Transmitter with a 1 ampere output.

The program will first set up the gains, buck out the SP automatically and then continue to gather data. Since "standard" gain is the default gain mode, the gain is put into G1 and then G2, and the input signal is amplified to a maximum of 3.0 volts. See *GDP Section 6.5, Gains*, for additional information.

```
GDP-32 II  MULTI-FUNCTION RECEIVER

0094 TEM 0539      12.3 15 Mar 98 08:57:49
Survey INL
Tx       1 Rx      3
  32 Hz      /  128 Cycle  Tx Curr    1
Window 1.549m  Delay 122.1u  Alias   26 u
CH    Station G0  G1  G2 Atn   SP     GGGA
1  Hz      1   1  64   1 OU*    3.24 0600
2  Hy      1   1  64   1 OU*    4.09 0600
3  Hx      1   1  64   1 OU*    2.78 0600




Setting Gains
                        TxOFF
```

F1	F2	F3	F4	F5	F6
DATA F7	EXIT F8	CAL F9	GAIN F10	SP F11	CRES F12

cρ **ZONGE ENGINEERING & RESEARCH ORGANIZATION, INC.**
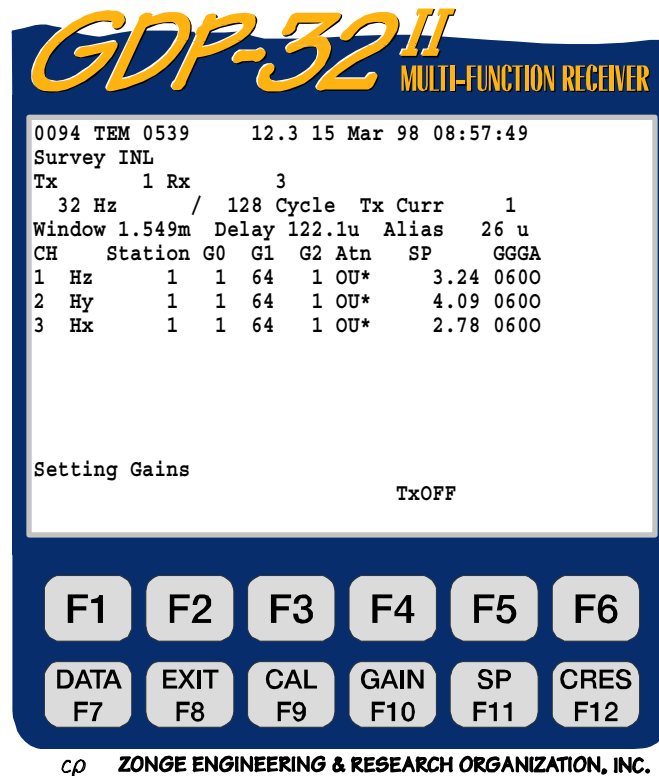
The display is self explanatory, but the following comments elaborate on some of the details.

G0, G1, G2. Gain stages 0, 1 and 2. The first gain stage (**G0**) is set to a gain of 1, the second gain stage (**G1**) is set to 64 and the third (**G2**) is set to 1.

Atn. The attenuator is bypassed (set to **OUT**). The designation of **OU***, indicates that the attenuator is fixed in the **OUT** position.

SP. The values of **SP** that have been bucked out are 3.24 mv for channel 1, 4.09 mv for channel 2, etc.

GGGA. Gain settings for stages 0, 1 and 2 (in powers of 2). For this example, gain stages 0 and 2 = 2^0 = 1, gain stage 1 = 2^6 = 64 and the attenuator is locked **OUT**, unless enabled by the operator.
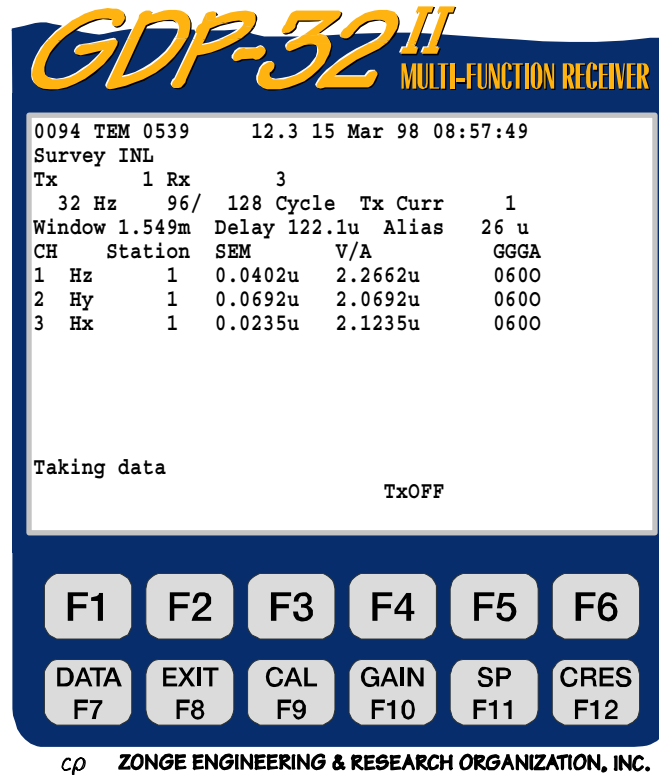
The program will acquire 128 cycles of data for all enabled channels (unless the [STOP AVG / Escape] key is pressed before completion) and the results will look similar to the following for real-time displays (while data are being acquired).

```
GDP-32 II  MULTI-FUNCTION RECEIVER

0094 TEM 0539      12.3 15 Mar 98 08:57:49
Survey INL
Tx        1 Rx        3
   32 Hz    96/  128 Cycle  Tx Curr     1
Window 1.549m  Delay 122.1u  Alias   26 u
CH    Station  SEM       V/A         GGGA
1  Hz       1   0.0402u   2.2662u     0600
2  Hy       1   0.0692u   2.0692u     0600
3  Hx       1   0.0235u   2.1235u     0600




Taking data
                            TxOFF

 F1    F2    F3    F4    F5    F6

DATA  EXIT  CAL   GAIN  SP   CRES
 F7    F8    F9    F10   F11   F12

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```

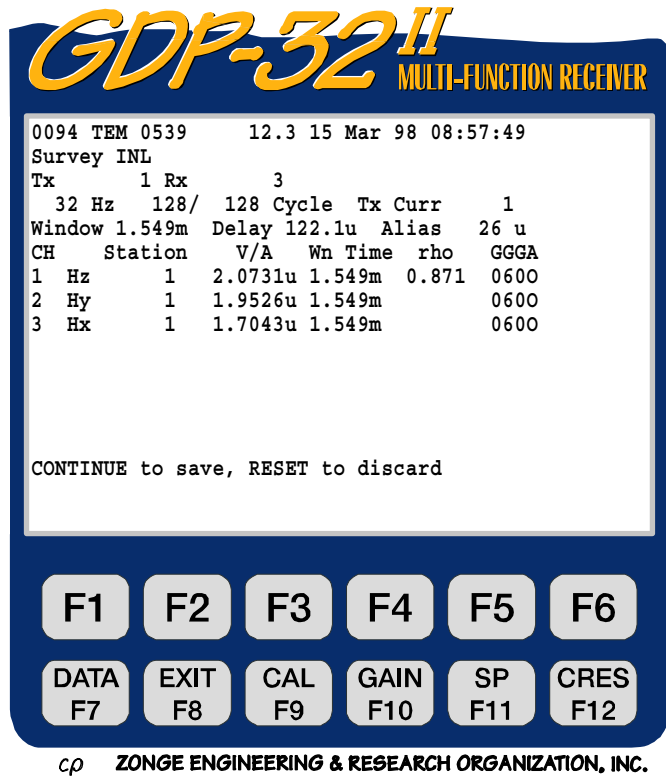**SEM.** Standard error of the mean, in volts per ampere calculated after each cycle, or burst of cycles, and based on the average value. Averaging should continue until SEM values are considerably less than the corresponding V/A value.

V/A. Average window value in volts per ampere. The window selected for monitoring in this example is number 16 (1.549 ms), as displayed above.

Notice that we have acquired 96 of 128 cycles so far.

After the selected number of cycles have been acquired (or **STOP AVG** **Escape** is pressed), the final display will appear as follows:

```
0094 TEM 0539      12.3 15 Mar 98 08:57:49
Survey INL
Tx       1 Rx        3
  32 Hz   128/  128 Cycle  Tx Curr    1
Window 1.549m  Delay 122.1u Alias   26 u
CH    Station    V/A   Wn Time  rho   GGGA
1  Hz      1   2.0731u 1.549m  0.871  060O
2  Hy      1   1.9526u 1.549m         060O
3  Hx      1   1.7043u 1.549m         060O




CONTINUE to save, RESET to discard
```

F1	F2	F3	F4	F5	F6
DATA F7	EXIT F8	CAL F9	GAIN F10	SP F11	CRES F12

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All function keys are active: **DATA F7**, **EXIT F8**, **CAL F9**, **GAIN F10**, **SP F11**, **CRES F12**.

V/A.   Value of window magnitude for window number displayed.

rho.   Apparent resistivity in ohm-meters for Hz component for window time displayed.

Upon pressing **CONTINUE Enter** to save the data (or **RESET** to discard the data), the only difference in screens is the change in block number (0095) and the bottom command line.

```
0095 TEM 0539      12.3 15 Mar 98 08:57:49
Survey INL
Tx       1 Rx        3
  32 Hz   128/  128 Cycle  Tx Curr    1
Window 1.549m  Delay 122.1u Alias   26 u
CH    Station    V/A   Wn Time  rho   GGGA
1  Hz      1   2.0731u 1.549m  0.871  060O
2  Hy      1   1.9526u 1.549m         060O
3  Hx      1   1.7043u 1.549m         060O




CONT-Take data, ESC-Prev Menu
```

F1	F2	F3	F4	F5	F6
DATA F7	EXIT F8	CAL F9	GAIN F10	SP F11	CRES F12

cρ **ZONGE ENGINEERING & RESEARCH ORGANIZATION, INC.**

Press the [DATA F7] function key to view the data. It will display the last stack taken. See **DATA Section 7.2, Viewing Data** for explanations. The data display is in the following format:

```
GDP-32 II  MULTI-FUNCTION RECEIVER

Block: 0095   Total:0095

TEM 0539 98-03-15 09:13:17 12.3v INL
Tx        1 Rx        3 N OUT
  32 Hz     128 Cyc Tx Curr     1 122.1u
1  Hz      1   2.0731u 1.549m  0.871  060O
2  Hy      1   1.9526u 1.549m         060O
3  Hx      1   1.7043u 1.549m         060O
  Wn      Mag 1     Mag 2     Mag 3    Rho 1
 31.07u  38.861m   39.013m   38.965m  0.854
 61.59u  21.049m   21.132m   21.106m  0.407
 92.11u  11.412m   11.456m   11.444m  0.312
 122.6u  6.1950m   6.2196m   6.2136m  0.290

   Select                    Plot  Skip
   Block                     Data  Flag
```

[F1] [F2] [F3] [F4] [F5] [F6]

[DATA F7] [EXIT F8] [CAL F9] [GAIN F10] [SP F11] [CRES F12]

$c\rho$ **ZONGE ENGINEERING & RESEARCH ORGANIZATION, INC.**

Notice that all of the decay data have not have been displayed. The apparent resistivity data, if calculated, will be to the right of the decay data.

To view the rest of the data press [NEXT FIELD Pg Dn] several times as needed.

To return to the first part of the display press [PREV FIELD Pg Up].

Again, you may have to press it several times. If we were running with more than one Hz channel in the above example, some of the data would have been off the screen to the right. The SEM, SP and contact resistance values have also been saved to the right of the screen.

To view these numbers   press ➡ several times to move to the right,

or   press ⬅ to move to the left.

The Window data are a combination of point and integrated values, normalized by the transmitter current. See the following section for window specifications. When you first enter the data mode, only the first few windows appear because all data will not fit onto the screen at one time; use the ⬇ or [NEXT FIELD Pg Dn] to see the rest.

Plot Data. By pressing F5 you get into the plot routines. See ***Plot Routines, Section 14*** for more information. Standard plots for this TEM program are transient voltage vs. time, and resistivity vs. image depth.

Skip Flag. By pressing F6 an '**x**' is placed between the version number and the date in the header for the block being viewed. This flag is recognized by the plot routines and the flagged data will be skipped when averaging multiple blocks for plotting. Repeated pressing of

F6 will remove and replace the '**x**'.

12.6   A NOTE ON SCALING

The following convention is used for all measured and calculated parameters:

TEM magnitudes, displayed in volts per ampere (V/A).

Current, displayed in amperes.

Apparent resistivity, displayed in ohm-meters.

Dipole spacings, displayed in meters. (Values not used in TEM).

SEM, displayed in volts per ampere (V/A)

If scaling is necessary on these values, the following labels are appended to the end of the number string:

M - Mega units

k   - Kilo units

m - milli units

u   - micro units

12.7   SAMPLE RATES AND ANTIALIAS FILTER DELAYS

FREQ Fo	SAMPLE RATE	SAMP'S /CYCLE	NYQUIST Fn	LOW PASS FILTER Fc	Delay	SAMPLE INTERVAL
32	32768	1024	16384	24.8 KHz	26 µs	30.5 µS
16	32768	2048	16384	24.8	26 µs	30.5 µS
8	32768	4096	16384	24.8	26 µs	30.5 µS
4	32768	8192	16384	24.8	26 µs	30.5 µS
2	16384	8192	8192	12.4	39 µs	61.0 µS
1	8192	8192	4096	6.4	64 µs	122.1 µS
.5	4096	8192	2048	3.2	118 µs	244.1 µS
.25	2048	8192	1024	1.6	226 µs	488.3 µS
.125	1024	8192	512	0.8	440 µs	976.6 µS
.0625	512	8192	256	0.4	880 µs	1,953 µS

12.8   TEM WINDOW CENTERS FOR ZERO DELAY

WINDOW #'S	32, 16, 8 and 4 Hz	2 Hz	1 Hz	.5 Hz	.25 Hz	.125 Hz	.0625 Hz
1	0.0 µs	0.0 µs	0.0 µs	0.0 µs	0.0 µs	0.0 ms	0.0 ms
2	30.5	61.0	122.0	244.1	488.3	976.6	1.953
3	61.0	122.1	244.1	488.3	976.6	1.953	3.906
4	91.6	183.1	366.2	732.4	1.465 ms	2.930	5.859
5	122.1	244.1	488.3	976.6	1.953	3.906	7.813
6	152.6	305.2	610.4	1.221 ms	2.441	4.883	9.766
7	197.8	395.6	791.1	1.582	3.164	6.329	12.66
8	259.0	517.9	1.036 ms	2.072	4.143	8.287	16.57
9	320.1	640.2	1.280	2.561	5.121	10.24	20.48
10	395.6	791.1	1.582	3.164	6.329	12.66	25.32
11	487.3	974.7	1.949	3.899	7.797	15.59	31.19
12	607.3	1.215 ms	2.429	4.858	9.717	19.43	38.87
13	774.5	1.549	3.098	6.196	12.39	24.78	49.57
14	972.3	1.945	3.889	7.778	15.56	31.11	62.23
15	1.215 ms	2.429	4.858	9.717	19.43	38.87	77.73
16	1.518	3.037	6.073	12.15	24.29	48.58	97.17
17	1.911	3.821	7.643	15.29	30.57	61.14	122.3
18	2.426	4.852	9.704	19.41	38.82	77.63	155.3
19	3.064	6.128	12.26	24.51	49.02	98.05	196.1
20	3.852	7.704	15.41	30.82	61.63	123.3	246.5
21	4.838	9.676	19.35	38.71	77.41	154.8	309.6
22	6.094	12.19	24.38	48.75	97.50	195.0	390.0
23	7.687	15.37	30.75	61.50	123.0	246.0	492.0
24	9.659	19.32	38.64	77.28	154.6	309.1	618.2
25	12.14	24.29	48.57	97.15	194.3	388.6	777.2
26	15.30	30.59	61.18	122.4	244.7	489.5	978.9
27	19.25	38.51	77.02	154.0	308.1	616.1	1232.3
28	24.24	48.48	96.96	193.9	387.8	775.6	1551.3
29	30.53	61.06	122.1	244.2	488.5	977.0	1954.0
30	38.42	76.83	153.7	307.3	614.7	1229.3	2458.6
31	48.38	96.76	193.5	387.1	774.1	1548.2	3096.4

For 32 Hz we get 22 windows for 50% duty cycle

25 windows for 16 Hz

28 windows for 8 Hz

31 windows for 4 Hz and below
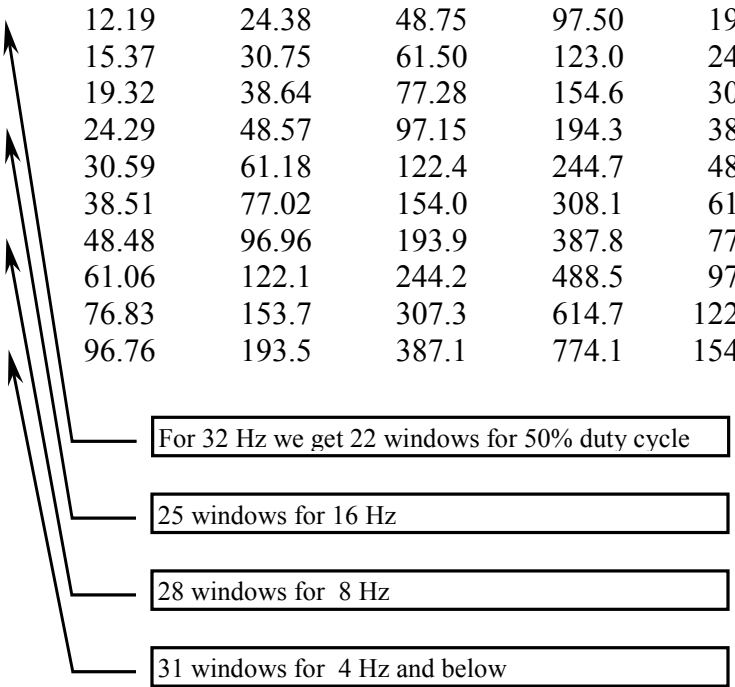
Window center times saved in the cache during data acquisition will be the above values plus the delay after turnoff. See *Section 12.10* for sample data blocks.

12.9   WINDOW CENTERS AND WIDTHS

32, 16, 8 and 4 HZ REPETITION RATES

WINDOW #'S	POINTS PER WINDOW	WINDOW CENTERS 32, 16, 8 and 4 Hz	WINDOW WIDTHS BEGINNING	END
1	1	0.0 μ sec	0.0 μ sec	0.0 μ sec
2	1	30.5	30.5	30.5
3	1	61.0	61.0	61.0
4	1	91.6	91.6	91.6
5	1	122.1	122.1	122.1
6	1	152.6	152.6	152.6
7	2	197.8	183.1	213.6
8	2	259.0	244.1	274.7
9	2	320.1	305.2	335.7
10	3	395.6	366.2	427.3
11	3	487.3	457.8	518.8
12	5	607.3	549.3	671.4
13	6	774.5	701.9	854.5
14	7	972.3	885.0	1.068 m sec
15	9	1.215 m sec	1.099 m sec	1.343
16	11	1.518	1.373	1.678
17	15	1.911	1.709	2.136
18	19	2.426	2.167	2.716
19	23	3.064	2.747	3.418
20	29	3.852	3.449	4.303
21	36	4.838	4.334	5.402
22	47	6.094	5.432	6.836 — 32 Hz
23	58	7.687	6.867	8.606
24	72	9.659	8.637	10.803
25	92	12.14	10.834	13.611 — 16 Hz
26	116	15.30	13.642	17.151
27	145	19.25	17.182	21.576
28	184	24.24	21.607	27.192 — 8 Hz
29	231	30.53	27.222	34.241
30	289	38.42	34.272	43.061
31	369	48.38	43.091	54.322 — 4 Hz

To find the window centers or beginning and ending sample points for the windows, just take these values and multiply them by the ratio of 4 Hz divided by the frequency of interest. For example to determine the window widths for a 2 Hz repetition rate, multiply the above numbers by 4/2 = 2, so for the 20th window the center would be 2 x 3.852 = 7.704 ms, and the beginning of the window would be at 2 x 3.449 = 6.898 ms, and ending at 8.606 ms.

12.10   SAMPLE DATA BLOCKS

```
0094
TEM 0539 98-03-15 08:57:47 12.3v INL
OPER  JOHN DOE TX ID    1 A-SP    100
JOB 94001 LINE        1 N  SPREAD 1
 50% RxM  10000 TxX    1 TxY    1 #T  1 Ref 0.113
Tx Delay   50 Antenna Delay  15 Alias IN
Robust None
1  LoPass  Notch+60,3-5,9  S/N   91 Passed 0.99382
2  LoPass  Notch+60,3-5,9  S/N   81 Passed 0.99478
3  LoPass  Notch+60,3-5,9  S/N   82 Passed 0.99368
4  LoPass  Notch+60,3-5,9  S/N   89 Passed 0.99341
5  LoPass  Notch+60,3-5,9  S/N   94 Passed 0.99094
6  LoPass  Notch+60,3-5,9  S/N   95 Passed 1.00041
7  LoPass  Notch+60,3-5,9  S/N   93 Passed 0.99464
8  LoPass  Notch+60,3-5,9  S/N   96 Passed 0.99739
Front Panel S/N   21, Cal S/N   13, Temp  27.1, Humidity  38.9, EPROM ZMT-32 Z201f

0095
TEM 0539 98-03-15 08:57:49 12.3v INL
Tx        1 Rx        3 N OUT
  32 Hz   1024 Cyc Tx Curr    1 122.1u   26u  30.50u
1  Hz      1  2.0731u  1.549m  0.871  060O 0.018u    3.24    287
2  Hy      2  1.9526u  1.549m      0  060O 0.016u    4.09    240
3  Hx      3  1.7403u  1.549m      0  060O 0.018u    2.78    256
  Wn       Mag 1     Mag 2     Mag 3     Rho 1
 31.07u  38.861m  39.013m  38.965m  0.8543
 61.59u  21.049m  21.132m  21.106m  0.4072
 92.11u  11.412m  11.456m  11.444m  0.3121
 122.6u  6.1950m  6.2196m  6.2136m  0.2907
 153.1u  3.3703m  3.3835m  3.3809m  0.3009
 183.6u  1.8385m  1.8463m  1.8452m  0.3327
 228.9u  782.51u  786.10u  786.43u  0.4072
 290.0u  244.84u  246.25u  247.21u  0.5951
 351.2u  84.190u  84.299u  85.328u  0.8812
 426.7u  30.488u  30.635u  31.588u  1.2534
 518.4u  14.444u  14.669u  15.164u  1.4902
 638.4u  9.0692u  9.0316u  9.4358u  1.4362
 805.6u  6.2024u  6.2712u  6.2056u  1.2554
 1.003m  4.1632u  4.3886u  3.9539u  1.1355
 1.246m  3.2232u  2.9787u  2.7866u  0.9390
 1.549m  2.0731u  1.9526u  1.7403u  0.8710
 1.942m  1.4938u  1.3632u  1.0208u  0.7480
 2.457m  0.9400u  0.8184u  0.5879u  0.6881
 3.095m  0.4965u  0.4728u  0.3523u  0.7167
 3.883m  0.4435u  0.3710u  0.3247u  0.5294
 4.869m  0.3140u  0.2078u  0.2462u  0.4570
 6.125m  0.1698u  0.1632u  0.0997u  0.4699
```

IN-LOOP array used

Duty Cycle
Rx Moment
Tx X & Y Lengths
turns
Ref coil factor

Gain factors for each card

Sampling Delay

Antialias Delay

Contact resistance

SP in millivolts

SEM

The first window time (31.1 µs) is calculated from the sum of Tx Delay (50), Antenna Delay (15) and Antialias Delay (26). The total delay is 91 µs. Subtract this from 122.1 (sampling delay) to give 31.1 µs for window one.

All other window times are then offset by 30.6 µs from the values given in the table in **Section 12.8.**

Apparent Resistivity (Ωm)

TEM Decay Curves

Window Center Times

12.11   FIELD SETUPS AND MAGNETIC ANTENNAS

The figures at the end of this TEM manual provide examples of receiver connections using the optional REFERENCE ELECTRODE or REFERENCE POT connected to both analog ground (**COM**) and case ground (**CASE GND**).

The **CASE GND** to **COM** connection is recommended for receivers making only magnetic measurements, since this tends to reduce noise in most environments.   The REFERENCE ELECTRODE is optional for magnetic measurements.

Another consideration is protection from static discharge and nearby lightning strokes.   This protection is maximized by connecting the case ground to the REFERENCE ELECTRODE.

TEM/3 magnetic coils with an active, differential (3-wire) output, should have the two signal wires connected to the red and black input terminals and the ground wire connected to **COM** on the analog side-panel.

Magnetic coils with a single-ended (2 wire) output (older TEM/3), should have the signal wire connected to the red input and the ground wire (or shield, if it is a coaxial cable) connected to the black input. If the coils have a separate power supply, you may want to consider connecting a common line from the power supply to the **GDP COM** connector, to avoid common mode problems.

Passive magnetic coils such as the TEM/1 cable-coil should be loaded with a 1000 ohm resistor across the two output signal wires, and these two wires connected to the red and black signal inputs on the GDP. The shield wire should then be connected to the analog ground (**COM**) on the analog side panel.

12.12   ESTIMATING RAMP-OFF TIME

For those clients that do not have the ramp turnoff meter for the GGT-Series transmitters, the following equation will provide a good estimate of the ramp turnoff time:

$$L \quad = \quad \text{length of loop side (meters)}$$
$$R \quad = \quad \text{loop resistance (ohms)}$$
$$T \quad = \quad \text{ramp turnoff time (microseconds)}$$

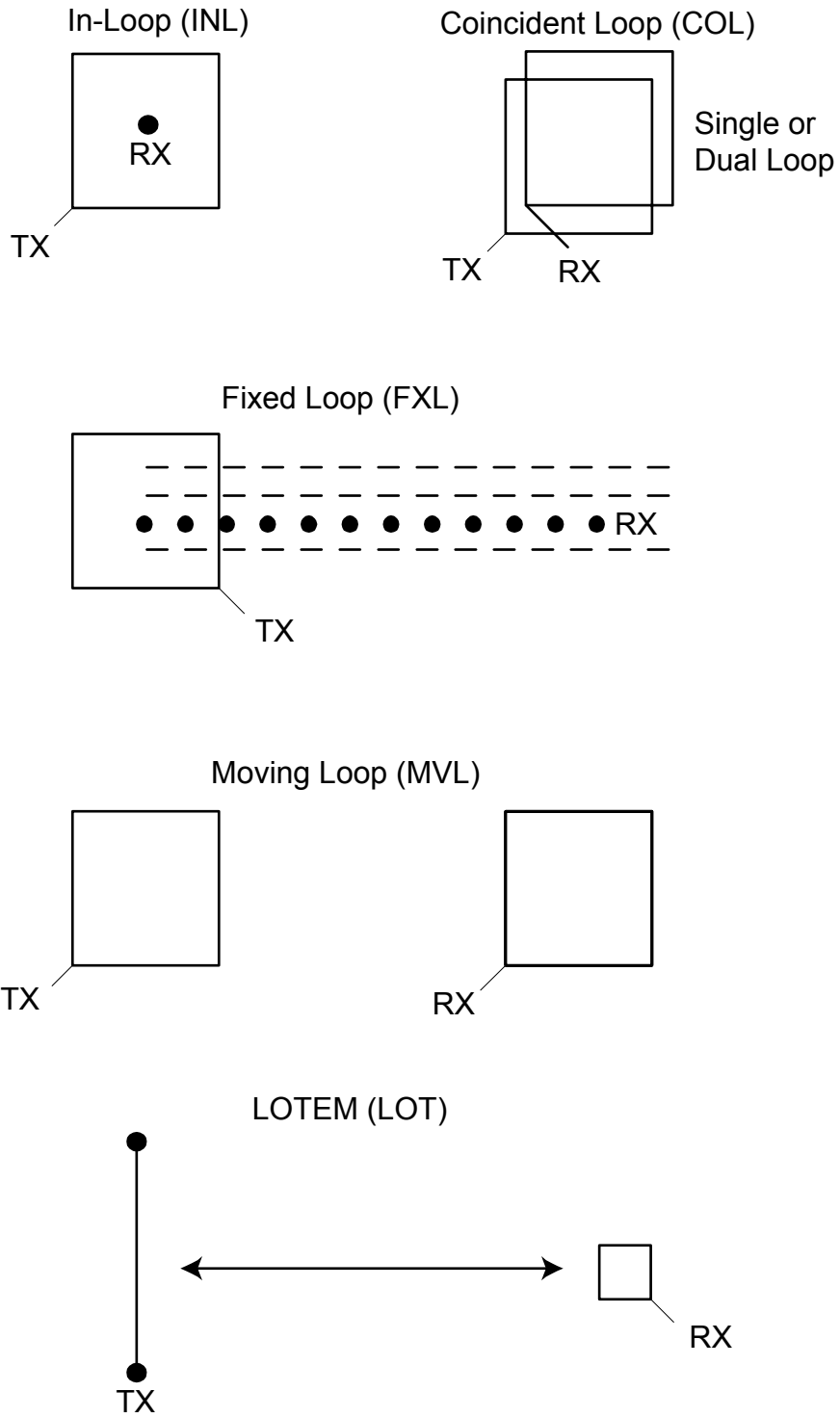$$T \quad = \quad \frac{2 * L^{1.25}}{5 + R}$$

For example, the turnoff time for a 100 x 100 meter loop with 4 ohms total resistance would be:

$$T \quad = \quad 2 * 100^{1.25} / (5 + 4) = 70 \ \mu\text{seconds}$$

If you are using a rectangular loop, use the average length of a side for L. Example: if you are running with a 300 x 600 meter loop, use (300 + 600)/2 = 450 meters for L.

12.13   TEM RECEIVER / TRANSMITTER ARRAYS
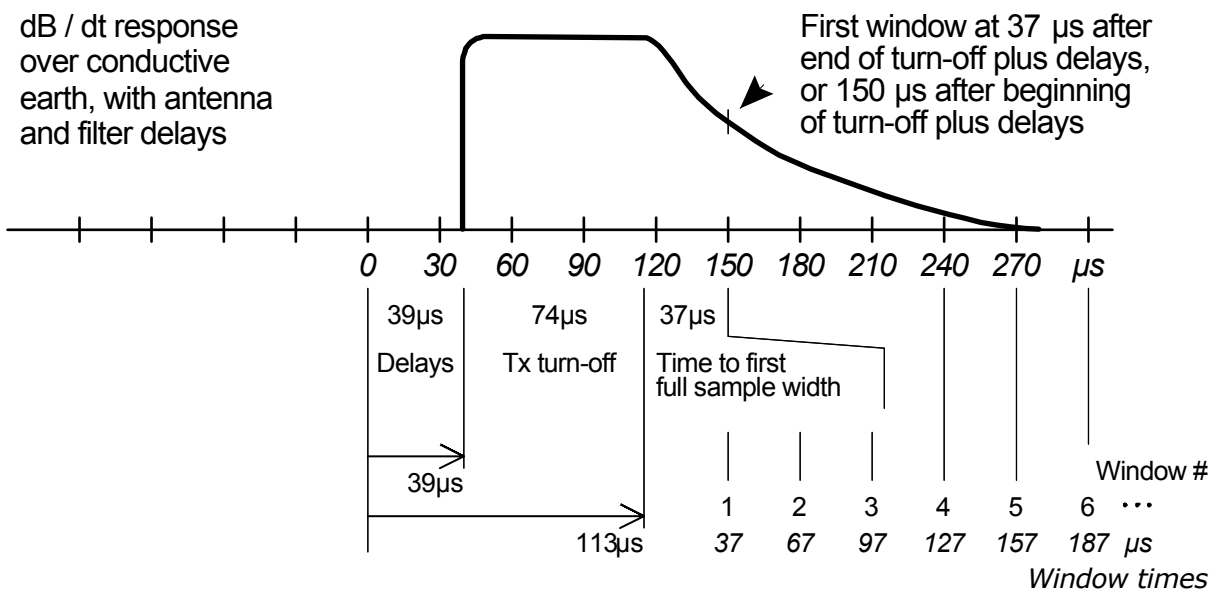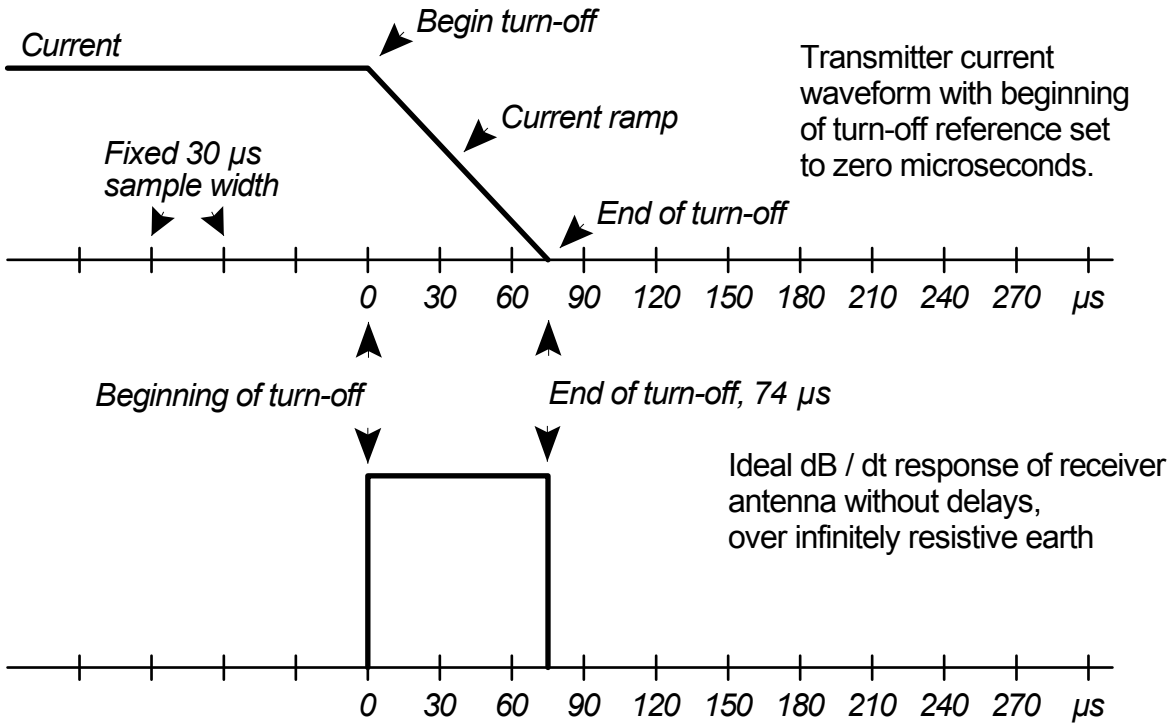
In-Loop (INL)

●
RX

TX

Coincident Loop (COL)

Single or
Dual Loop

TX   RX

Fixed Loop (FXL)

● ● ● ● ● ● ● ● ● ● ● RX

TX

Moving Loop (MVL)

TX   RX

LOTEM (LOT)

●

←——————————————→

□
RX

●
TX

12.14   FIRST WINDOW TIME DETERMINATION

Assume for this example:
  Fixed sample width = 30 µs
  Current turn-off   = 74 µs

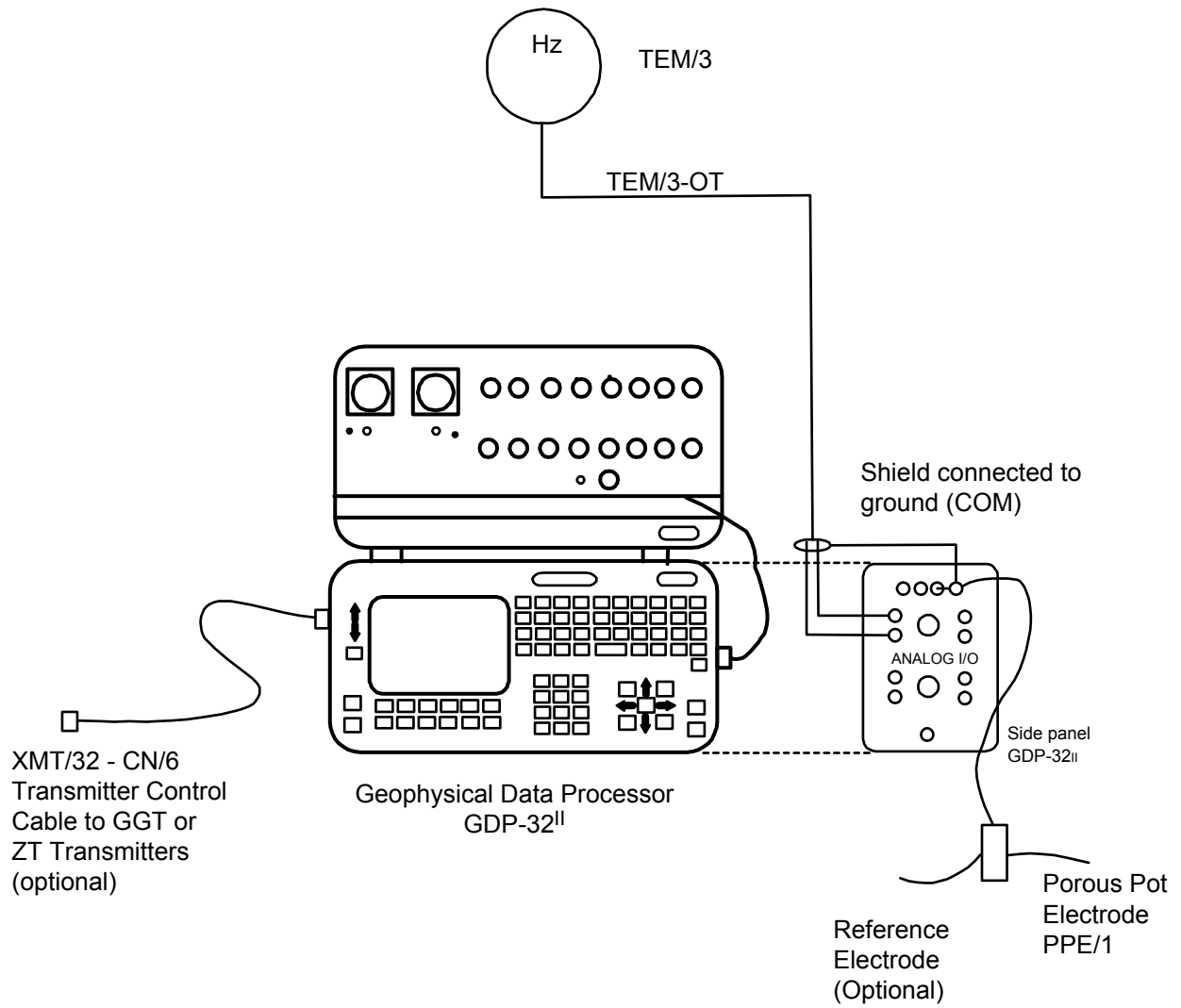| Antenna delay	15
Filter delay	24
Total delays	39 µs

Current

Begin turn-off

Fixed 30 µs sample width

Current ramp

End of turn-off

Transmitter current waveform with beginning of turn-off reference set to zero microseconds.

0   30   60   90   120   150   180   210   240   270   µs

Beginning of turn-off

End of turn-off, 74 µs

Ideal dB / dt response of receiver antenna without delays, over infinitely resistive earth

0   30   60   90   120   150   180   210   240   270   µs

dB / dt response over conductive earth, with antenna and filter delays

First window at 37 µs after end of turn-off plus delays, or 150 µs after beginning of turn-off plus delays

0   30   60   90   120   150   180   210   240   270   µs

39µs	74µs	37µs
Delays	Tx turn-off	Time to first full sample width

39µs

113µs

	Window #

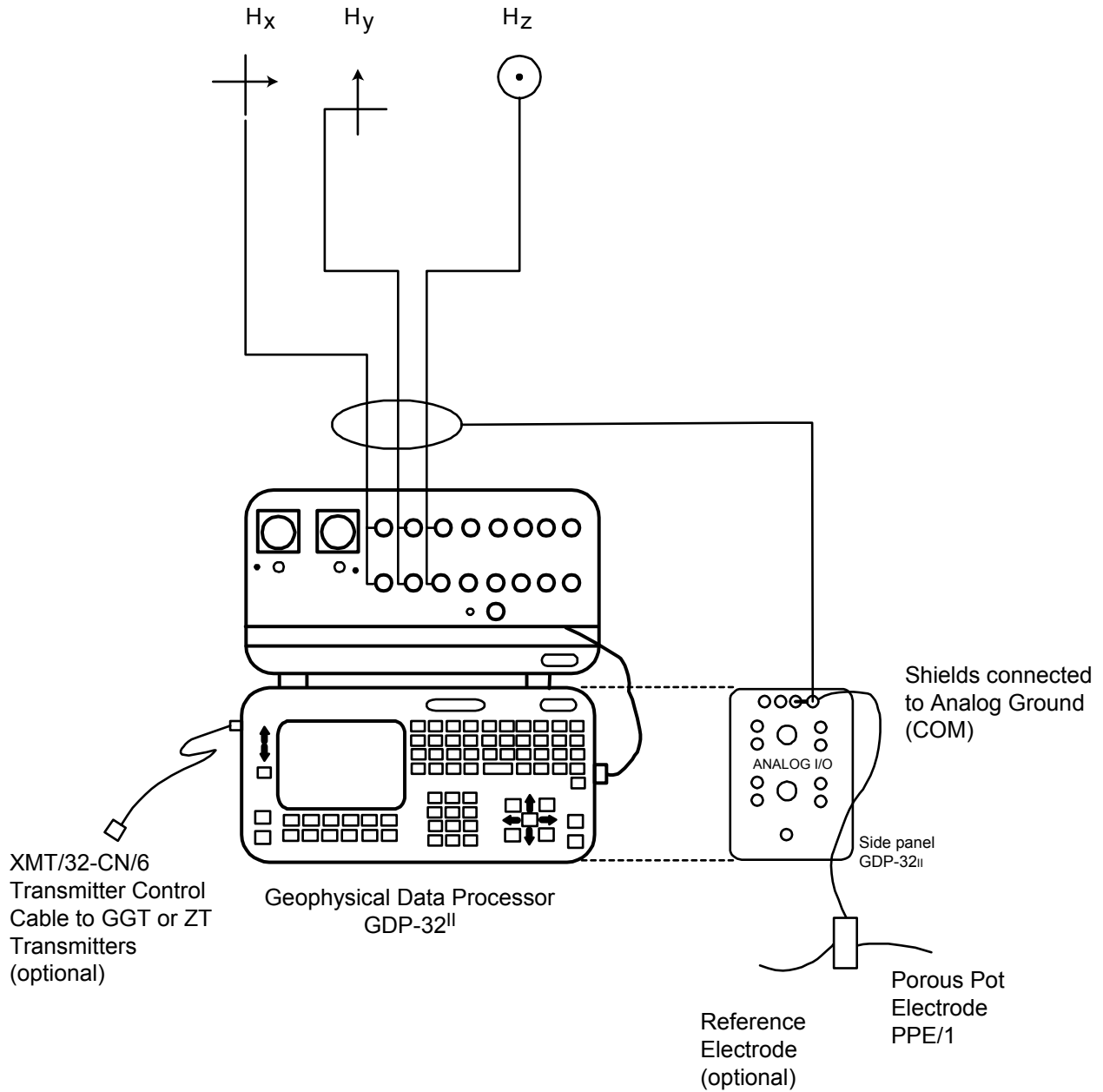| 1	2	3	4	5	6	···
37	67	97	127	157	187	µs

Window times

The software is set so that the first window time is always equal to or greater than one sample width, or in this case greater than 30 µs.

12.15 FIELD CONFIGURATIONS

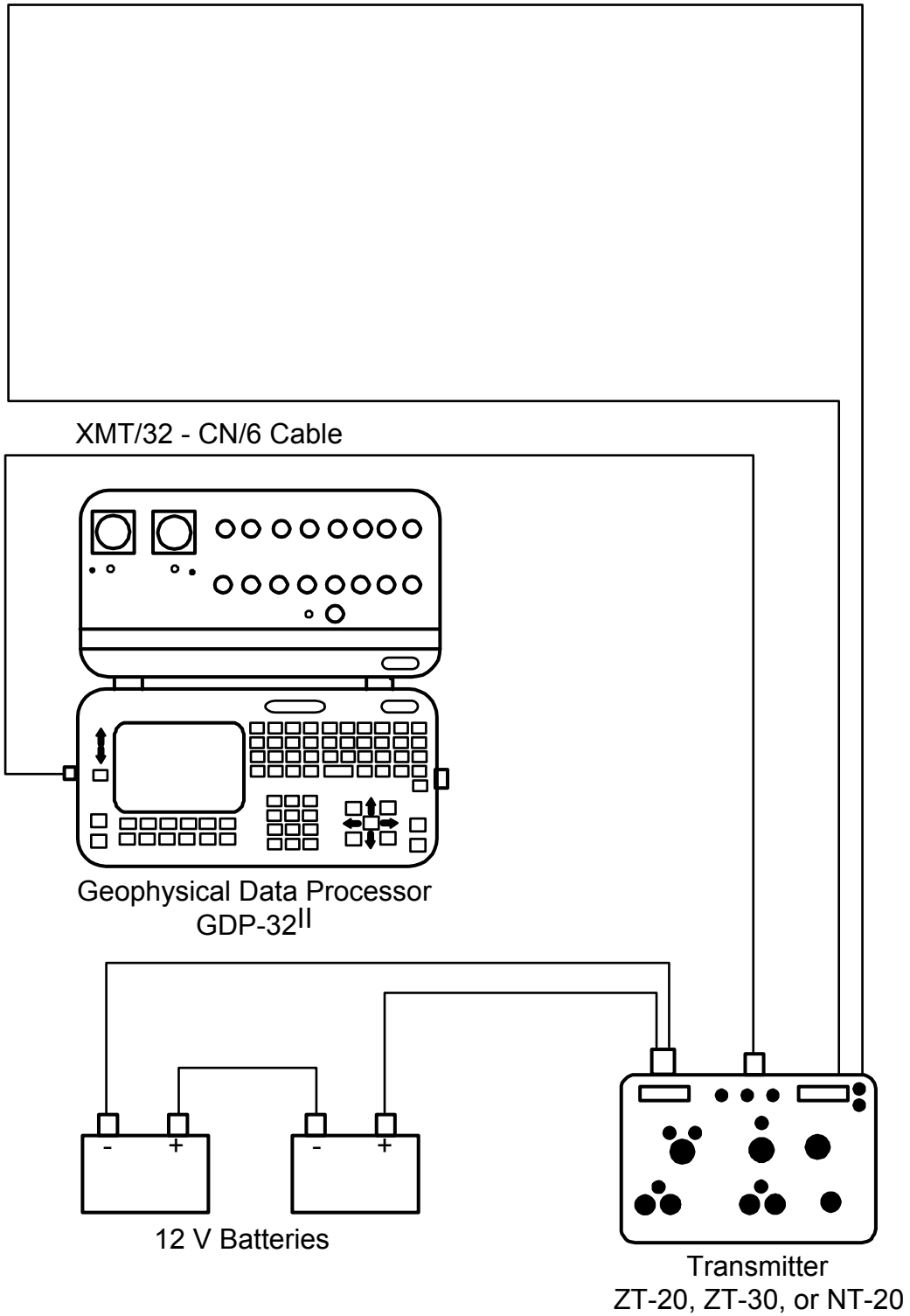**TEM RECEIVER SETUP WITH Z-AXIS COIL**

TEM RECEIVER WITH 3-AXIS (X,Y,Z) COILS

H$_x$ H$_y$ H$_z$

Shields connected
to Analog Ground
(COM)

ANALOG I/O

Side panel
GDP-32$_{II}$

XMT/32-CN/6
Transmitter Control
Cable to GGT or ZT
Transmitters
(optional)

Geophysical Data Processor
GDP-32^{II}

Reference
Electrode
(optional)

Porous Pot
Electrode
PPE/1

ZT-20 ZEROTEM TRANSMITTER SETUP (STANDARD)

Loop wire from BR12W or PR / 1W with PW / 1

XMT/32 - CN/6 Cable

Geophysical Data Processor
GDP-32^{II}

12 V Batteries

Transmitter
ZT-20, ZT-30, or NT-20

ZT-20 ZEROTEM TRANSMITTER SETUP (XMT-32)

Loop wire from BR12W or PR/1W with PW/1

XMT/32 - CN/32 Cable

Transmitter Controller
XMT-32

12 V Batteries

Transmitter
ZT-20, ZT-30, or NT-20
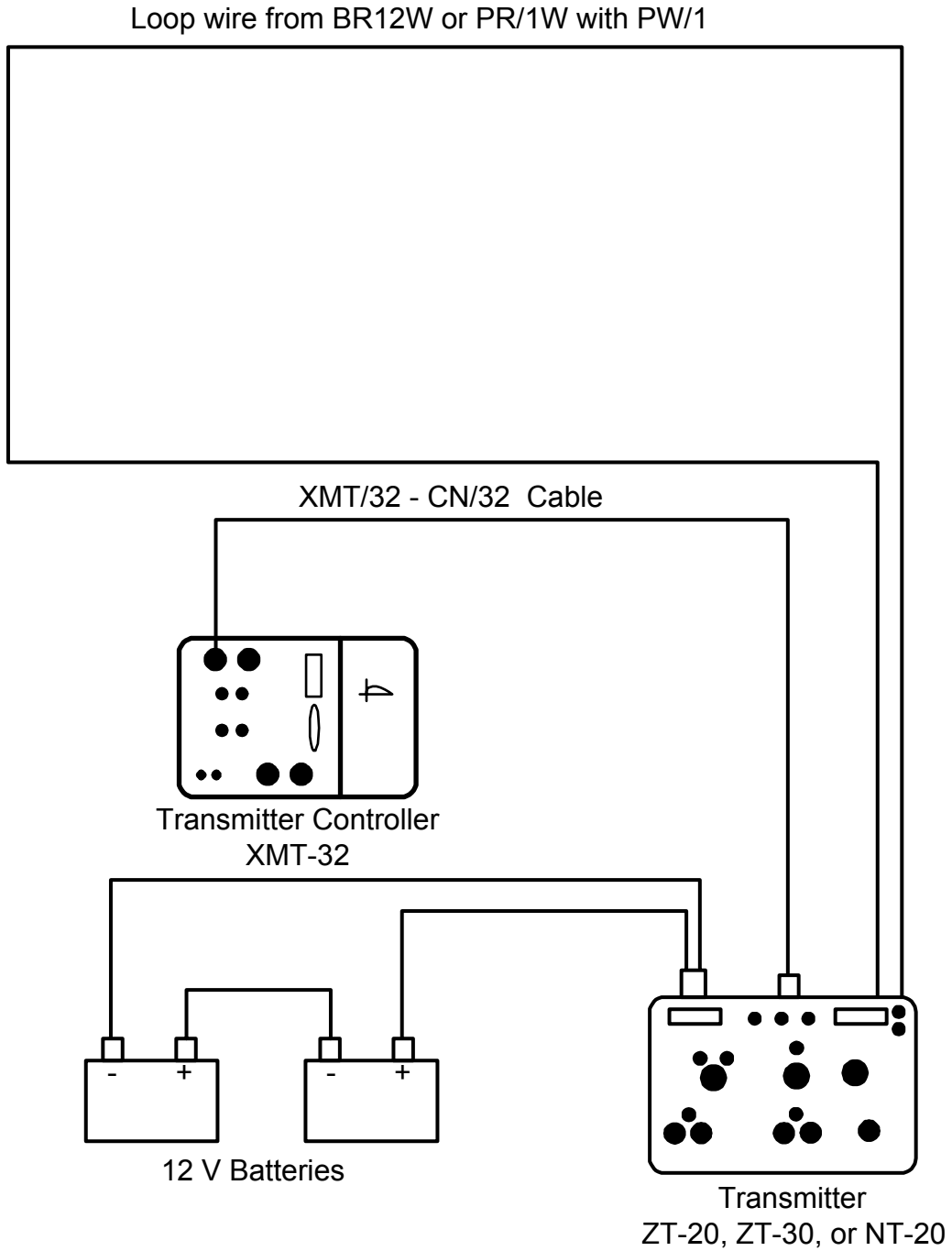
HIGH-POWER TEM TRANSMITTER SETUP

VR-CN/6 Cable

Voltage
Regulator
VR-1

Motor
Generator
ZMG-30

GGT-30-PW
Cable

Transmitter
GGT-30

XMT/32 - CN/6 Cable
(optional)

XMT/32 - CN/6 Cable

Wire from BR12/W or
PR/1W with PW/1

To GDP-32ıı
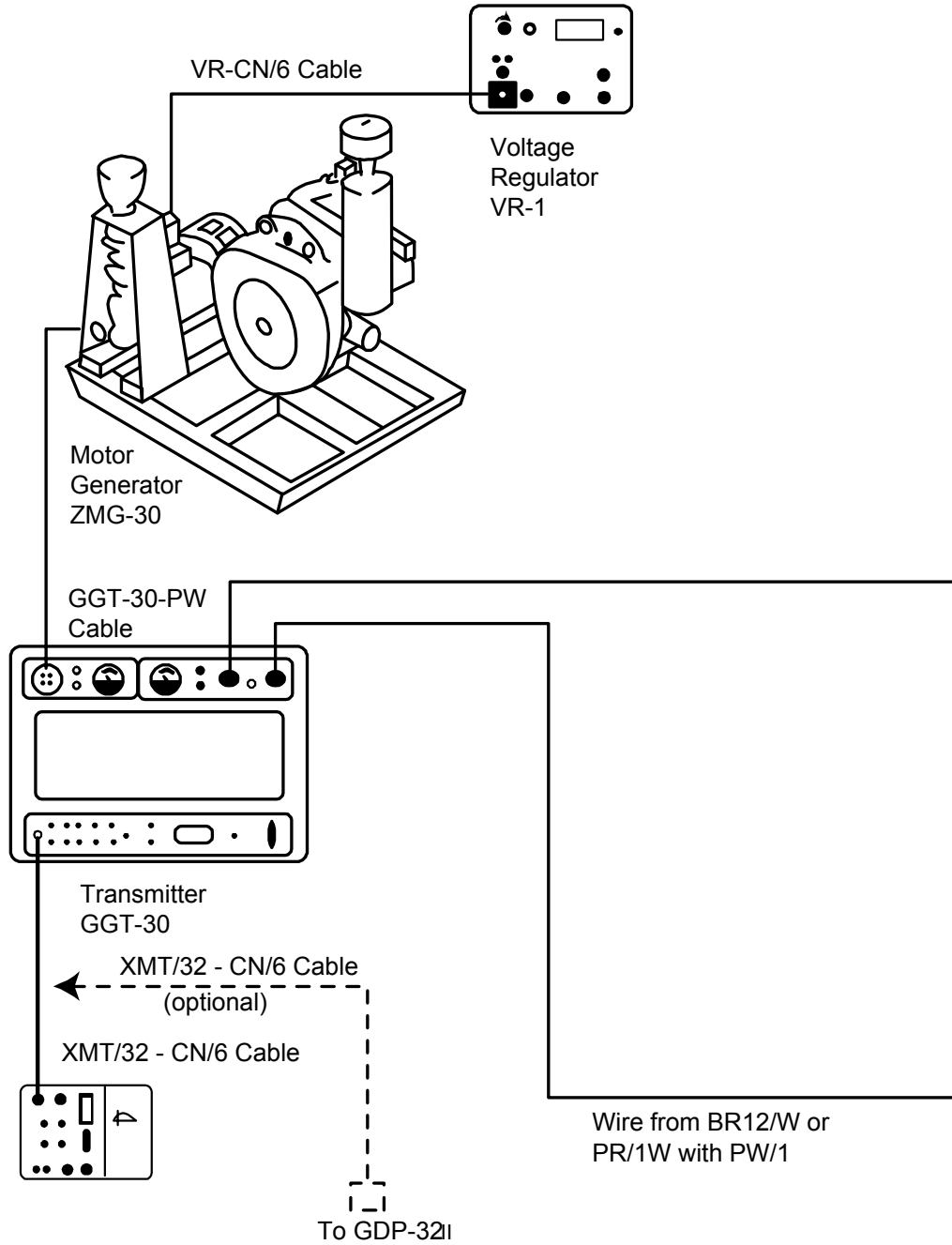
12.16   EQUAL-INTERVAL MODE, TEM

General

A version of the TEM program that runs on the Zonge GDP-32^{II} receiver permits TEM transients to be uniformly sampled and stored as time series to the hard disk. The window parameter may be toggled between **ZONGE STANDARD**, **SHALLOW** and **EQUAL INTERVAL** acquisition modes.   The **ZONGE STANDARD** TEM data acquisition modes are described in the TEM sections of this manual. When the TEM program is operating in the **EQUAL INTERVAL** mode, it writes the program name TEME to each of the data blocks stored to the data cache.

The program stores the first 31 samples of the transient time series to the data cache using a format identical to that of the TEM program. However, the entire transient waveform that usually contains many more samples is written to a disk file whose name is **BLKnnnn.TEM** where **nnnn** is a 4-digit integer corresponding the GDP32^{II} block number of the data measurement. The transient data files are written in binary for efficient storage and data transfer. But they are easily transformed into ASCII text format using one of DOS executable utilities furnished when a receiver is purchased with this version of the TEM program.

The TEM Equal Interval program can handle a maximum of 65536 bytes of data. Since each sample point takes 4 bytes, the maximum number of sample points that can be acquired is 16384. Divide this number by the number of channels to determine the number of samples per channel that can be acquired.

Operating Instructions

With a few minor differences as explained below, the TEME program operates the same as the TEM program.

MENU 1:

Select the **EQUAL INTERVAL** option by moving the cursor to the **WINDOWS** field and toggling between **EQUAL INTERVAL**, **SHALLOW**, and **ZONGE STANDARD** options. The remaining parameters are the same as in the standard TEM program.

MENU 4:

In MENU 4 (the last menu before data are acquired) there are three selectable parameter fields:

Width: This field selects the sample interval. The minimum sample interval is governed by the frequency selected in the Frequency parameter field of this menu (see page TEM-16 of the GDP-32^{II} manual). Sample intervals ranging from 30.4 µs to 1.946 ms are selectable. At frequencies below 4 Hz, the minimum sample interval changes on binary increments from 60.8 µs up to 1.946 ms.

Start: This field specifies the delay time in sample intervals from the logic time of current turn-off to the first sample of the transient. No corrections for transmitter delay filter delays antenna delays, or current turnoff times are applied. Delays of up to a quarter of a period are permitted (i.e., Start $\leq T/(4\Delta t)$).

Count: This field specifies the number of samples to be acquired. Note there will be a maximum number of samples that can be acquired that is equivalent to a time period of T/4 (i.e. Count $\leq T/(4\Delta t)$).
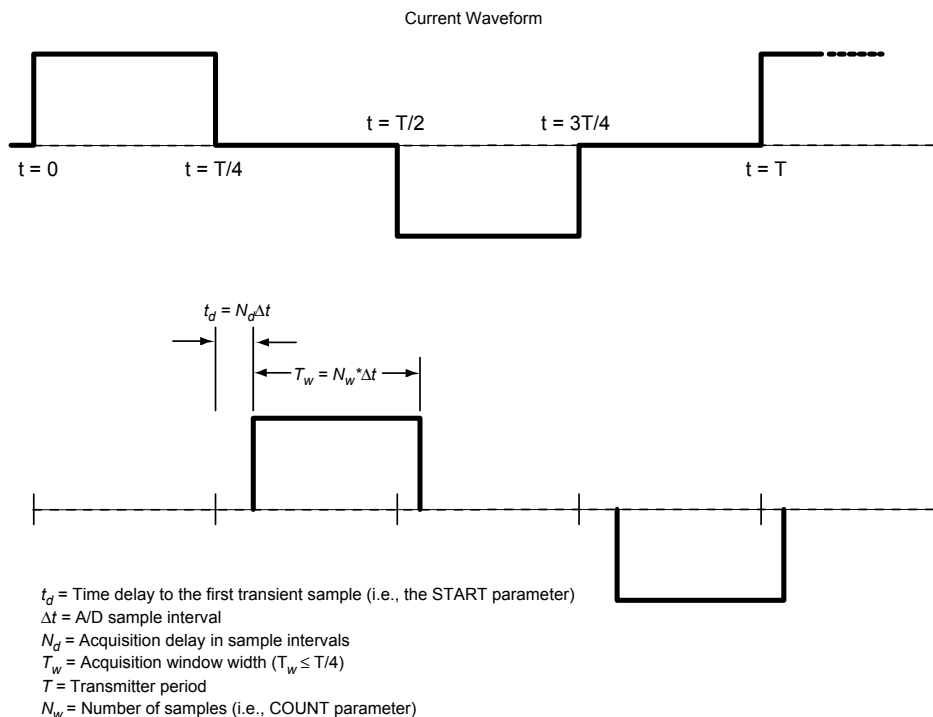
Data Inspection and Downloading

The sampled data falling within the gates as defined above and illustrated in the accompanying figure are rectified and stacked. These data are stored both in the data cache and as binary files on the hard disk. Only the first 31 data points are stored in the cache. They may be viewed and/or dumped from the DATA menu using procedures common to all the programs. The binary files are stored on the hard disk with the name **BLKnnnn.TEM**, where **nnnn** is an integer corresponding to the block number of the corresponding partially complete data set stored in the data cache.

The binary data may be downloaded using either the LAN connection or the serial port. The steps for downloading are listed below:

1. While the GDP-32^{II} power is off, connect it to either a LAN or to the serial port of another computer (a null modem must be used).

2. Turn on the GDP-32^{II} and run Windows.

3. If using the LAN, you may have to re-configure the network parameters in the GDP-32^{II} to be compatible with your network.

4. If using the serial port, HyperTerminal is the recommended program to use. You will have to ensure that the two serial ports are configured identically.

5. The data files are stored in **d:\data**.

Binary data files with the extension IGG may be inspected by converting them to ASCII format. The utility program **TEMASCII.EXE** converts a binary file to an ASCII text file of the same name with extension **PRN**.

The source code for this utility program is included so that users or customers have prototype C code for reading a binary file containing uniformly sampled transient data.

Current Waveform

$t_d = N_d \Delta t$

$T_w = N_w * \Delta t$

t_d = Time delay to the first transient sample (i.e., the START parameter)
Δt = A/D sample interval
N_d = Acquisition delay in sample intervals
T_w = Acquisition window width ($T_w \leq T/4$)
T = Transmitter period
N_w = Number of samples (i.e., COUNT parameter)

Explanation of the EQUAL INTERVAL mode data acquisition mode in the GDP-32^{II} TEM program

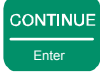## 12.17   METHOD TO FIELD-CHECK MAGNETIC SENSORS

It is possible to field check the operation of an antenna by using the GDP calibrator as a signal source as follows:

1. Connect a 1 K ohm resistor between the **Channel-1 Black** and **Red** input terminals.

2. Take a piece of wire or test lead and make a single turn around the antenna case as shown on the diagram. Connect one end of the wire to the Negative **CALIBRATE** output and the other end to the Negative (**Black**) input terminal for **Channel-1**.

3. Connect a test lead from the **Red CALIBRATE** output to **Channel-1 Red** Input.

4. Connect the coil output cable to the **Channel-2** inputs as shown on the diagram.

5. Turn on the receiver and enter the CSAMT program. Set **Channel-1** to **Ex** and **Channel-2** to **Hy** with the antenna number set to **1**.

6. Set the frequency to the lowest value you want to check - for instance 0.125 Hz.

7. Turn on the antenna.

8. Enter the calibrate program by pressing the **[CAL F9]** key. Then press **3) Auto System Check** and then press **2) External**. Press **[CONTINUE Enter]** to finish setting up the external calibrate system, and to begin taking data.

9. The program will automatically acquire data for each frequency, for example 0.125 Hz through 8192 Hz.

10. Enter the data mode by pressing the **[DATA F7]** key. Check to see the block number of the first data acquired. Then return to the last data block.

11. Enter the plot mode by pressing **[F5]**. Press **3) Magnitude Plot**.

12. Enter the starting block number and press **[CONTINUE Enter]**.

13. Enter the starting channel number = **2** and press **[CONTINUE Enter]**.

14. The plot that you get will be the magnitude plot for the coil being tested. It should have the same shape as the calibration done in our test facility.

15. If you want to look at the difference between a calibrate stored in the receiver and the response from this test, go back to step 4 and set the antenna number to the proper value for the antenna under test. Follow the same steps as outlined above. The result when you plot the data will be a straight line.

Note: The reason for monitoring the current through the 1 K ohm resistor is to make sure that the signal level is constant over the frequency range being tested.
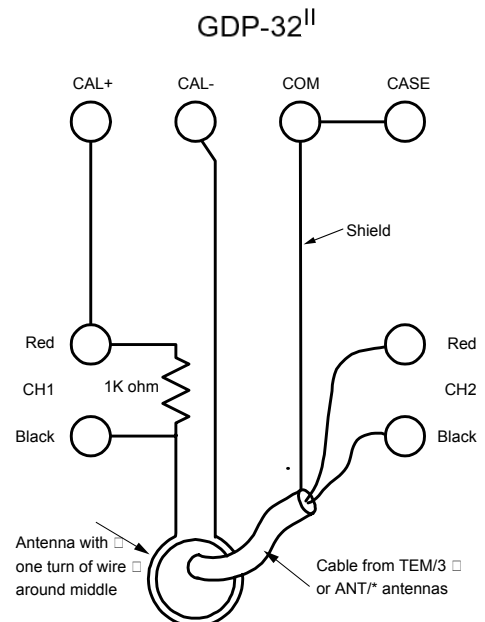
GDP-32^{II}

12.18   THE NANOTEM SYSTEM

The NanoTEM system is a very fast turnoff and sampling TEM option available for the GDP-32[II] receivers. The equipment consists of a high-speed sampling card (Board 194) for the GDP, a battery powered NanoTEM transmitter and a few loading resistors.

The receiver board samples the decay waveform at either 1.2 or 1.6 microsecond intervals, and then stores the data in an on-board memory buffer. Then the data are transferred to the main GDP memory where the samples are combined to form time windows on a logarithmic scale.

The NanoTEM transmitter is configured for very fast turn-off, is powered by a 12-volt battery, and can output up to 4 amperes. Two versions of the NanoTEM transmitter are available. The first, the NT-20, is an external transmitter system, and the second is the NT-32 that utilizes a transmitter integrated within the GDP-32[II] case.

Operating instructions for the NT-20 transmitter are included in a separate manual included with the NT-20. Instructions for effective operation of the NT-32 system are included in ***Section 12.20***.

*NOTE: Board 194 has a fixed gain stage of x10, which cannot be changed. Therefore, the receiver moment must be multiplied by a factor of 10 (as shown in **Section 12.19**, step 9) to get the correct resistivity numbers. There is also a variable gain stage with selections of 1, 2, 4, 8 and 16, which can be set automatically with the NanoTEM program.*

NanoTEM Configuration

> NanoTEM Card for the GDP-32[II]
>
> NT-20 or NT-32 Transmitter
>
> Wire for TX loop - 10 x 10 m, 20 x 20 m, etc.
>
> Wire for RX loop - presently using 5 x 5 m by 1 turn for 20 m TX loops and 10 x 10 m for 40 m TX loops.
>
> Battery for NT-20 or NT-32
>
> Battery charger
>
> Cable: RX loop to GDP - twisted pair with 150 ohm load resistor with alligator clips on the receiving antenna end and a 1 kΩ balanced bridge resistor on the other end, which plugs into the GDP. The cable should be approximately 14 meters long for a 20 x 20 m loop.
>
> Cable: transmitter control - from NT-20 to GDP
>
> Cable: battery power for NT-20
>
> Two options:
>
> > a) cable for using two 12 Volt car batteries
> >
> > b) cable for using 12/24 Volt 10 amp-hour battery pack

CAUTION: NanoTEM operation requires 12-volt supply only.

12.19 NANOTEM HOOKUP DIRECTIONS

Using a 20 X 20 m Transmitter Loop and NT-20 or NT-32 Transmitter

1. Use the 1 K-ohm bridge that is supplied. Plug it into the input for the channel that has the NanoTEM card (channel 3 in this example), and connect the ground wire to COM.

2. The 150 ohm resistor mounted on the Pomona plug must be connected across the receiver coil as shown in *Section 12.26*.

3. Observe the color-coded hookups as shown to get the proper polarity for received data.

4. VERY IMPORTANT: Upon turn-on, the NT-20 transmitter may come up on a setting other than a 20 meter loop. You MUST set it to the proper loop size to get the proper turn-off time.

5. For 20 meter loop operation, run the TX at 3 amps. Maximum current is about 4 amps.

6. Insulate the clips on the ends of the 20 meter TX loop sections to make sure you do not have leakage. This is not necessary in very dry conditions.

7. Do the same for the resistor load on the RX antenna, which is 5x5 meters for this example.

8. Header information from **Menu 1**:

    Array Type   : NanoTEM
    Duty cycle   : 50%
    Receiver moment : 250
    Transmitter X,Y   : 20 , 20   Turns: 1
    TX delay   : 1.5 microseconds
    Antenna delay   : 2 microseconds
    Transmitter type   : NT-20 (NT-32 if available in instrument)
    Automatic gain mode
    Alias filter IN

9. Note that the receiver moment is set to 250 meters squared even though the RX loop is 5 x 5 meters. The extra factor of 10 compensates for a gain of 10 on the NanoTEM card.

10. If using the NT-32 transmitter, pressing the GAIN/F10 key, then entering 8 from the data collection menu will accesses configuration of the NT-32 internal transmitter. The damping resistor should be set to 250 and transmitter loop size set to 20.

11. Take two stacks of 1024 cycles, unless the data are coming in clean with shorter stacks.

Using Transmitter Loops Other Than 20 Meters

If you are using an NT-20 transmitter, be sure to set the **LOOP SIDE** switch on the NT-20 to the closest smaller value for the transmitter loop being used. For example, a 61-meter loop should be set to 50 meters on the NT-20. The new loop dimensions should also be entered in Menu 1.
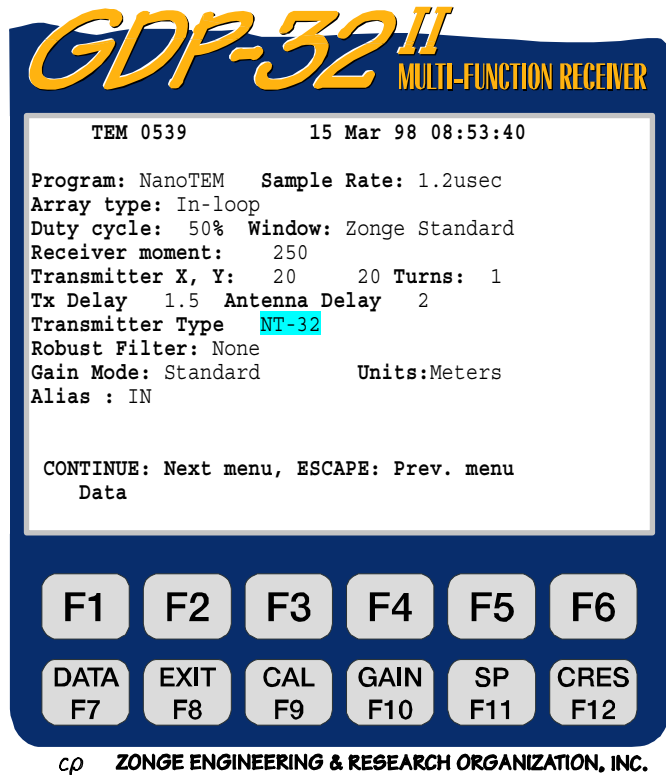
If you are using an NT-32 transmitter, the damping resistor value may be changed to correspond to the loop dimensions. A chart for estimated damping resistor values is included at the end of *Section 12.20*.

12.20   NT-32 TRANSMITTER SYSTEM

Setup of the NanoTEM system using the NT-32 transmitter is similar to the steps used when using all of the other Zonge Transmitter systems.
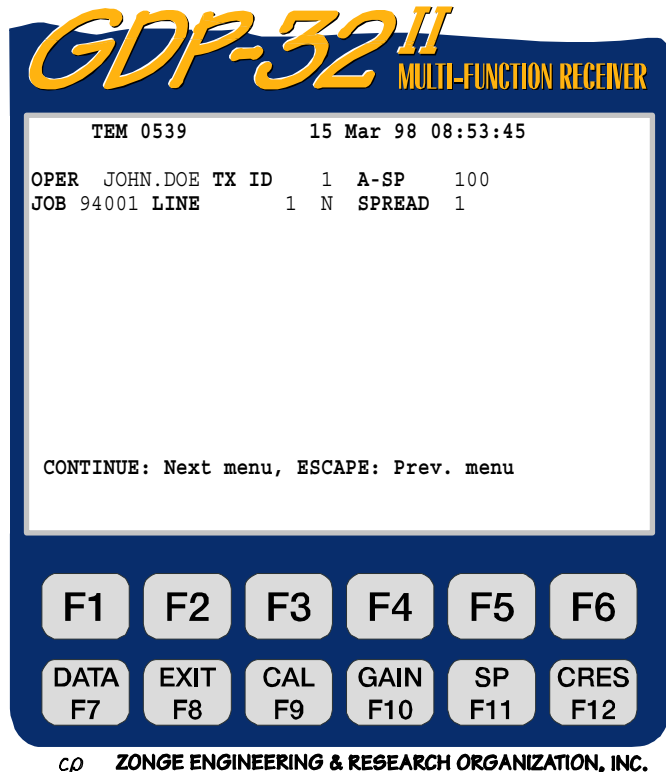
Menu 1

Configuration information is entered into Menu 1 in the GDP-32^{II} data program as outlined in ***Section 12.5***. Of particular importance is the Transmitter Type, which should be set to **NT-32**.

```
      TEM 0539           15 Mar 98 08:53:40

Program: NanoTEM   Sample Rate: 1.2usec
Array type: In-loop
Duty cycle:  50%  Window: Zonge Standard
Receiver moment:    250
Transmitter X, Y:   20     20 Turns:  1
Tx Delay   1.5  Antenna Delay   2
Transmitter Type   NT-32
Robust Filter: None
Gain Mode: Standard        Units:Meters
Alias : IN


 CONTINUE: Next menu, ESCAPE: Prev. menu
    Data
```

F1	F2	F3	F4	F5	F6
DATA F7	EXIT F8	CAL F9	GAIN F10	SP F11	CRES F12

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Menu 2

After initializing the NT-32 Transmitter, the data collection program continues on to Menu 2 allowing entry of record keeping information such as line number, operator name, etc. A-Spacing (**A-SP**) is displayed in this menu, but it is not used for NanoTEM.

```
      TEM 0539           15 Mar 98 08:53:45

OPER  JOHN.DOE TX ID   1  A-SP    100
JOB 94001 LINE       1  N  SPREAD  1






 CONTINUE: Next menu, ESCAPE: Prev. menu
```

F1	F2	F3	F4	F5	F6
DATA F7	EXIT F8	CAL F9	GAIN F10	SP F11	CRES F12

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Menu 3

Menu 3, as with all of the data collection programs in the GDP-32[II], allows individual channels to be enabled, station numbers to be entered for each channel, and configuration information for the channels (Hx, Hy, or Hz) to be entered. Below is a configuration for making vertical magnetic field measurements at three separate stations.

```
0094 TEM 0539          15 Mar 98 08:57:47

OPER  JOHN DOE TX ID   1  A-SP    100
JOB 94001 LINE         1 N  SPREAD  1

CH   Station
1  Hz      1
2  Hz      2
3  Hz      3




Enter channel parameters
                        Ch Info
```

F1 F2 F3 F4 F5 F6

DATA F7   EXIT F8   CAL F9   GAIN F10   SP F11   CRES F12

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Menu 4

Menu 4 is the primary data collection screen. Control over the configuration of the NT-32 transmitter is gained though pressing GAIN F10 key while in this menu. The other portions of this menu are described in detail in **Section 12.5**.

```
0094 NANOTEM 0610   12.3v   15 Mar 98 08:57:49
Survey In loop               Stacks    1
Tx       1 Rx        3       NT32 Battery: 12.0 V
  32 Hz   128/  128 Cycles   NT32 Current:  1.1
Window 1.549m  Delay 122.1u  Alias   1 u
CH    Station    V/A  Wn Time  rho   GGGA
1   Hz      1   2.0731u 1.549m  0.871  0600
2   Hy      1   1.9526u 1.549m         0600
3   Hx      1   1.7043u 1.549m         0600



CONTINUE-Set Gains, Esc-Prev Menu
```
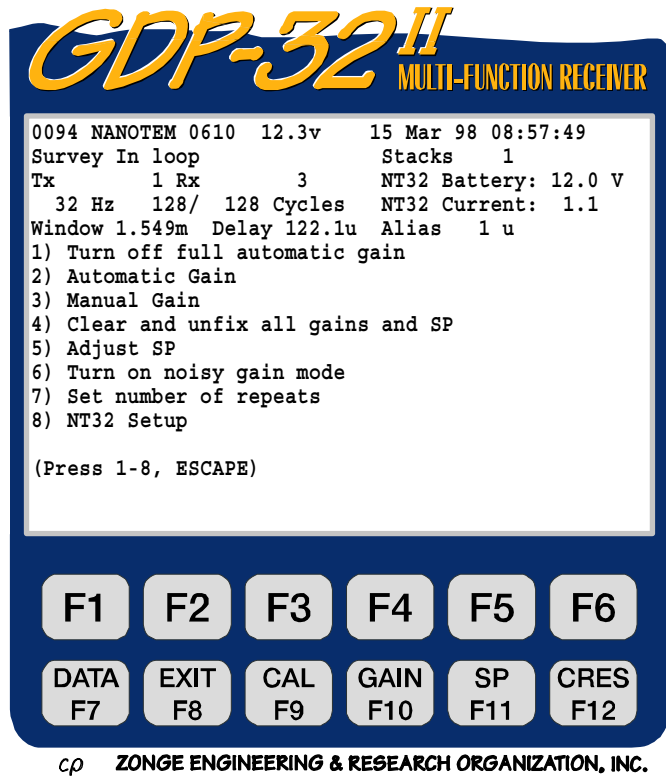
F1 F2 F3 F4 F5 F6

DATA F7   EXIT F8   CAL F9   GAIN F10   SP F11   CRES F12

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Gain/F10 SubMenu

The setup menu for the NT-32 transmitter can be accessed by pressing **8.** This will bring up the NT-32 configuration menu.

```
0094 NANOTEM 0610  12.3v    15 Mar 98 08:57:49
Survey In loop              Stacks    1
Tx        1 Rx        3      NT32 Battery: 12.0 V
  32 Hz   128/  128 Cycles   NT32 Current:  1.1
Window 1.549m  Delay 122.1u  Alias   1 u
1) Turn off full automatic gain
2) Automatic Gain
3) Manual Gain
4) Clear and unfix all gains and SP
5) Adjust SP
6) Turn on noisy gain mode
7) Set number of repeats
8) NT32 Setup

(Press 1-8, ESCAPE)
```
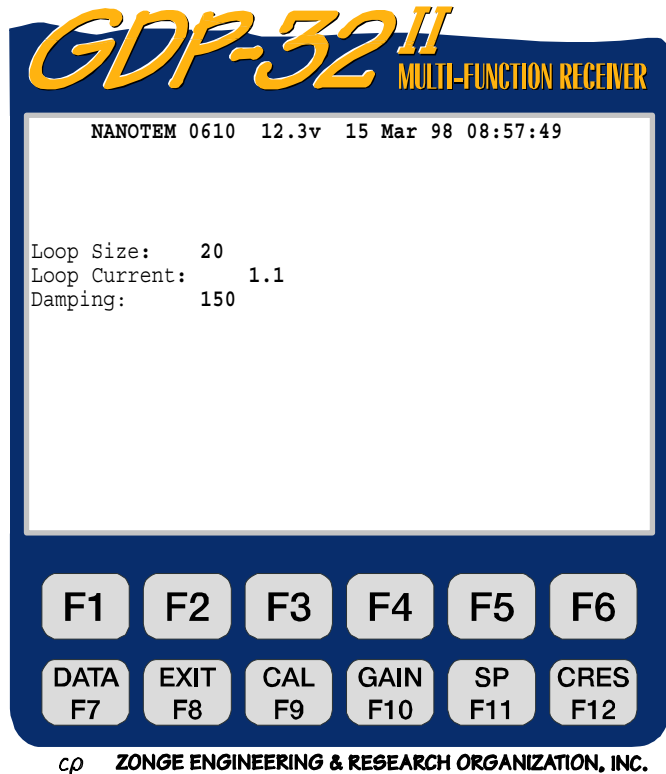
F1 F2 F3 F4 F5 F6
DATA F7 | EXIT F8 | CAL F9 | GAIN F10 | SP F11 | CRES F12

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NT-32 Configuration Menu

Loop Size: Transmitter loop side in meters

Loop Current: Adjust output current (measured in Amperes)

Damping: Damping resistance in ohms, determined by the Tx loop size.

```
   NANOTEM 0610  12.3v  15 Mar 98 08:57:49




Loop Size:    20
Loop Current:     1.1
Damping:      150
```

F1 F2 F3 F4 F5 F6
DATA F7 | EXIT F8 | CAL F9 | GAIN F10 | SP F11 | CRES F12

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Damping: Adjustment for transmitter damping resistors. Damping resistance values are available from 50 to 1550 ohms in steps of 50 ohms. These values can be changed by pressing

SELECT UP Home and **SELECT DN** End . The best choice for damping resistors is a complex function of the loop size and the electrical resistivity of the area in which measurements are being made. The chart below offers estimates of damping values for different transmitter geometries.

Tx Loop Size (m)	Damping Resistance (ohms)
5	100
10	150
20	250
40	450
80	850
100	1000

12.21   NANOTEM TURNOFF TIMES

The following are some approximate turnoff times for a selection of transmitter loop sizes:

Loop Size	Turnoff Time
10 x 10 meter loop	1.2 μs
20 x 20 meter loop	1.5
40 x 40 meter loop	3.0
100 x 100 meter loop	6.0

The NanoTEM program has been used successfully in highly conductive as well as highly resistive environments.

12.22   NANOTEM FIELD DATA CACHE

At this time, all of the GDP-32^{II} programs, except for the NanoTEM program, initialize the data cache according to the outline in Chapter 7.4. Initialize the NanoTEM data cache as follows:

If you are in the NanoTEM program, get into the first menu and

Press **2   Utilities,** then

Press **6   Turn off power**, then

Press **CONTINUE** Enter

The LOGO screen will now be displayed. This is also where you will enter the program if you have just turned the receiver on. The cache file may be deleted using either a DOS or WINDOWS procedure.

DOS PROCEDURE FOR NANOTEM CACHE INITIALIZATION:

Press **F1** to get into DOS. The **C:\>** prompt will be displayed.

Type: **DEL NTDATA.CAC**

Type: **DIR /P** and page through the files. **NTDATA.CAC** should not be included.

Type: **MENU**

The LOGO screen will now be displayed.

WINDOWS PROCEDURE FOR NANOTEM CACHE INITIALIZATION:

Press **F2** to get into WINDOWS

If you do not have a mouse attached, press **CONTINUE Enter** (OK) for Mouse Support display box.
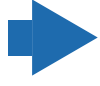
Press **CONTINUE Enter** (YES) for the DHCP box

Windows EXPLORER is now activated

Press **SHIFT** - **NEXT FIELD Pg Dn** to see the bottom of the display and the file listings

Press ⬇ until you highlight the file **NTDATA.CAC**

Press **DEL**. The following message will appear

Are you sure you want to send **NTDATA.CAC** to the recycle bin?

If YES is not highlighted, press ➡ to highlight YES

Press **CONTINUE Enter**. **NTDATA.CAC** should be deleted from the screen

Press **SHIFT** - **SELECT DN End** to view the lower left-hand part of the screen

Press **CTRL** - **STOP AVG Escape**

Press the down arrow to highlight **SHUT DOWN**

Press **CONTINUE Enter**

Press ⬇ and **CONTINUE Enter** to **RESTART** the computer, if desired,

Otherwise press **CONTINUE Enter** to turn the computer off.

Press **SHIFT** - **SELECT UP Home** to get back to the original position of the screen

DATA TRANSFER FROM NANOTEM CACHE

Data from the data cache (**NTDATA.CAC**) can be downloaded or transferred by two methods. The direct method uses a RS-232 (COM 1) serial port transfer from the NanoTEM program as explained in ***Chapter 7, page 13***. Large files will require a long time to transfer with this method. A fast alternative method is to use the LAN and connect to a network or a laptop PC. The files transferred by this method need to be reformatted with the NTCNVRT.EXE program that is included on the Zonge software CD-ROM.

1. Turn off the GDP-32^{II}

2. Connect the GDP-32^{II} to the network using the multi-function interface cable.

3. Start the GDP and get into WINDOWS as described in the previous section. Once WINDOWS is running, the GDP-32^{II} should appear in the Network Neighborhood of the other computers on the network. The device name for the GDP is "**GDP32ii SNxx**" where **xx** is the GDP front panel serial number. The NanoTEM cache file is located in **d:\data**.

4. Now you can drag files from the GDP (or copy updated programs to the GDP). Place the program NTCNVRT.EXE into the same folder as the **NTDATA.CAC** cache file you wish to convert.

5. Double click on the icon for NTCNVRT.EXE

6. The program will convert the **NTDATA.CAC** file in the folder to an ASCII file **NTDATA.PRN**. To use Zonge Engineering data processing software rename the file **NTDATA.RAW** and begin the data processing with the programs SHRED.EXE and TEMAVG.EXE.

12.23   NANOTEM WINDOW CENTERS

SAMPLE PERIOD: 1.6 MICROSECONDS

Zero Delay After Current Turnoff

WINDOW #'S	POINTS PER WINDOW	WINDOW CENTERS	WINDOW WIDTHS BEGINNING	END
1	1	0.0 µ sec	0.0 µ sec	0.0 µ sec
2	1	1.6	1.6	1.6
3	1	3.2	3.2	3.2
4	1	4.8	4.8	4.8
5	1	6.4	6.4	6.4
6	1	8.0	8.0	8.0
7	2	10.4	9.6	11.2
8	2	13.6	12.8	14.5
9	2	16.8	16.1	17.7
10	3	20.8	19.3	22.5
11	3	25.6	24.1	27.3
12	5	32.0	28.9	35.3
13	6	40.8	36.9	45.0
14	7	51.2	46.6	56.2
15	9	63.9	57.8	70.7
16	11	79.9	72.3	88.3
17	15	100.6	89.9	112.4
18	18	127.7	114.0	142.9
19	23	161.2	144.5	179.9
20	29	202.7	181.5	226.4
21	36	254.6	228.1	284.3
22	47	320.7	285.9	359.7
23	58	404.5	361.4	452.9
24	72	508.3	454.5	568.5
25	92	639.0	570.1	716.3
26	116	804.9	717.9	902.6
27	145	1.013 m sec	904.2	1.135 m sec
28	184	1.276	1.137 m sec	1.431
29	231	1.607	1.433	1.802
30	289	2.022	1.804	2.266
31	369	2.546	2.268	2.859

To demonstrate how to determine the actual window times, we will use the 20 meter loop parameters as an example: add the Tx delay (1.5 µs) plus the antenna delay (2.0 µs) plus the antialias filter delay (1.0 µs) = 4.5 µs. The first sample point after the Tx turnoff and delays is at 4.8 µs (3 x 1.6), so the first window will be at 4.8 - 4.5 = 0.3 µs. The next window will be 1.6 + 0.3 = 1.9 µs, then 3.2 + 0.3 = 3.5 µs, for the next window, etc.

SAMPLE PERIOD: 1.2 MICROSECONDS

Zero Delay After Current Turnoff

WINDOW #'S	POINTS PER WINDOW	WINDOW CENTERS	WINDOW WIDTHS BEGINNING	END
1	1	0.0 μ sec	0.0 μ sec	0.0 μ sec
2	1	1.2	1.2	1.2
3	1	2.4	2.4	2.4
4	1	3.6	3.6	3.6
5	1	4.8	4.8	4.8
6	1	6.0	6.0	6.0
7	2	7.8	7.2	8.4
8	2	10.2	9.6	10.8
9	2	12.6	12.1	13.3
10	3	15.6	14.5	16.9
11	3	19.2	18.1	20.5
12	5	24.0	21.7	26.5
13	6	30.6	27.7	33.7
14	7	38.4	34.9	42.2
15	9	48.0	43.4	53.0
16	11	59.9	54.2	66.3
17	15	75.4	67.5	84.4
18	19	95.8	85.6	107.2
19	23	121.0	108.5	135.0
20	29	152.1	136.2	169.9
21	36	191.0	171.1	213.3
22	47	240.6	214.5	269.9
23	58	303.5	271.1	339.8
24	72	381.4	341.0	426.6
25	92	479.5	427.8	537.4
26	116	604.0	538.6	677.2
27	145	760.2	678.4	851.9
28	184	957.1	853.1	1,074
29	231	1,205	1,075	1,352
30	289	1,517	1,353	1,700
31	369	1,910	1,701	2,145

To demonstrate how to determine the actual window times, we will use the 20 meter loop parameters as an example: add the Tx delay (1.5 μs) plus the antenna delay (2.0 μs) plus the antialias filter delay (1.0 μs) = 4.5 μs. The first sample point after the Tx turnoff and delays is at 4.82 μs (4 x 1.205), so the first window will be at 4.82 - 4.5 = 0.32 μs. The next window will be 1.2 + 0.32 = 1.52 μs, then 2.41 + 0.32 = 2.73 μs, for the next window, etc.

SAMPLE PERIOD: 1.2 MICROSECONDS, SHALLOW APPLICATIONS

Zero Delay After Current Turnoff

WINDOW #'S	POINTS PER WINDOW	WINDOW CENTERS	WINDOW WIDTHS BEGINNING	END
1	1	0.0 u sec	0.0 u sec	0.0 u sec
2	1	1.2	1.2	1.2
3	1	2.4	2.4	2.4
4	1	3.6	3.6	3.6
5	1	4.8	4.8	4.8
6	1	6.0	6.0	6.0
7	1	7.2	7.2	7.2
8	2	9.0	8.4	9.6
9	2	11.4	10.8	12.0
10	2	13.8	13.3	14.5
11	2	16.3	15.7	16.9
12	3	19.2	18.1	20.5
13	3	22.9	21.7	24.1
14	4	27.0	25.3	28.9
15	5	32.4	30.1	34.9
16	6	39.0	36.1	42.2
17	7	46.8	43.4	50.6
18	8	55.9	51.8	60.2
19	9	66.1	61.4	71.1
20	11	78.1	72.3	84.3
21	14	93.0	85.6	101.2
22	17	111.6	102.4	121.7
23	20	133.8	122.9	145.8
24	24	160.2	147.0	174.7
25	29	192.0	175.9	209.7
26	35	230.4	212.3	251.8
27	42	276.6	253.0	302.4
28	50	331.8	303.7	362.7
29	59	397.3	363.9	433.8
30	70	474.7	435.0	518.1
31	85	567.7	519.4	620.6

To demonstrate how to determine the actual window times, we will use the 20 meter loop parameters as an example: add the Tx delay (1.5 us) plus the antenna delay (2.0us) plus the antialias filter delay (1.0us) = 4.5us. The first sample point after the Tx turnoff and delays is at 4.8us (4 x 1.2), so the first window will be at 4.8 - 4.5 = 0.3us. The next window will be 1.2 + 0.3 = 1.5us, then 2.4 + 0.3 = 2.7us, for the next window, etc.

12.24 NANOTEM SAMPLE DATA

```
0778
NANO0534 94-12-31 17:58:13 11.7v INL
OPER        SAU TX ID  T-21 A-SP        1
JOB 94118 LINE          4 N  SPREAD  1
 50% RxM  10000 TxX    1 TxY    1 #T  1 Ref 0.113
Tx Delay  1.5 Antenna Delay    2 Alias IN
Robust None
1  LoPass  Notch+60,3-5,9  S/N  117 Passed 1.00014
2  LoPass  Notch+60,3-5,9  S/N  114 Passed 0.99794
3  NanoTem A/D   14-bit    S/N    2 Passed 1.00000
Front Panel S/N   21, Cal S/N   15, Temp  20.0, Humidity  51.4, EPROM ZMT-32 Z201s
```

NanoTEM Channel 3

```
0779
NANO0534 94-12-31 18:00:05 11.6v INL
Tx        1 Rx        3 N OUT
  32 Hz    512 Cyc Tx Curr    1 4.819u    1u  1.606u
3  Hz       3 59.005u  80.23u  12.97  040O 14.61u    0.00      0
  Wn      Mag 3     Rho 3
 0.319u  19.863m  2692.5
 1.925u  4.8605m  343.38
 3.531u  2.8371m  178.83
 5.137u  2.0226m  119.96
 6.743u  1.4475m  95.275
 8.350u  1.1190m  79.222
 10.73u  900.31u  60.311
 13.95u  611.69u  50.388
 17.16u  499.88u  40.790
 21.14u  391.33u  33.942
 25.97u  294.99u  29.080
 32.28u  221.91u  24.461
 41.08u  162.99u  20.108
 51.49u  118.19u  17.097
 64.24u  86.311u  14.580
 80.23u  59.005u  12.974
 100.9u  51.056u  9.7527
 128.0u  38.916u  7.8601
 161.6u  30.188u  6.3142
 203.1u  22.741u  5.2111
 255.0u  20.282u  3.8488
 321.0u  18.985u  2.7393
 404.9u  14.122u  2.2663
 508.7u  12.730u  1.6603
 639.4u  8.2726u  1.5116
 805.4u  6.1923u  1.2482
 1.014m  4.9634u  0.9859
 1.276m  3.1665u  0.9065
 1.607m  2.7103u  0.6845
 2.022m  0.9478u  0.9404
 2.547m  0.1911u  1.8622
```

The above data were acquired using a dummy load on an NT-20 transmitter.

12.25   THE NANOTEM CALIBRATE BOX

The NanoTEM Calibrate Box is a resistor-capacitor network that provides a load for the NT-20 Transmitter when operating in the NanoTEM mode, which generates a decay transient suitable for measurement in the NanoTEM decay windows.
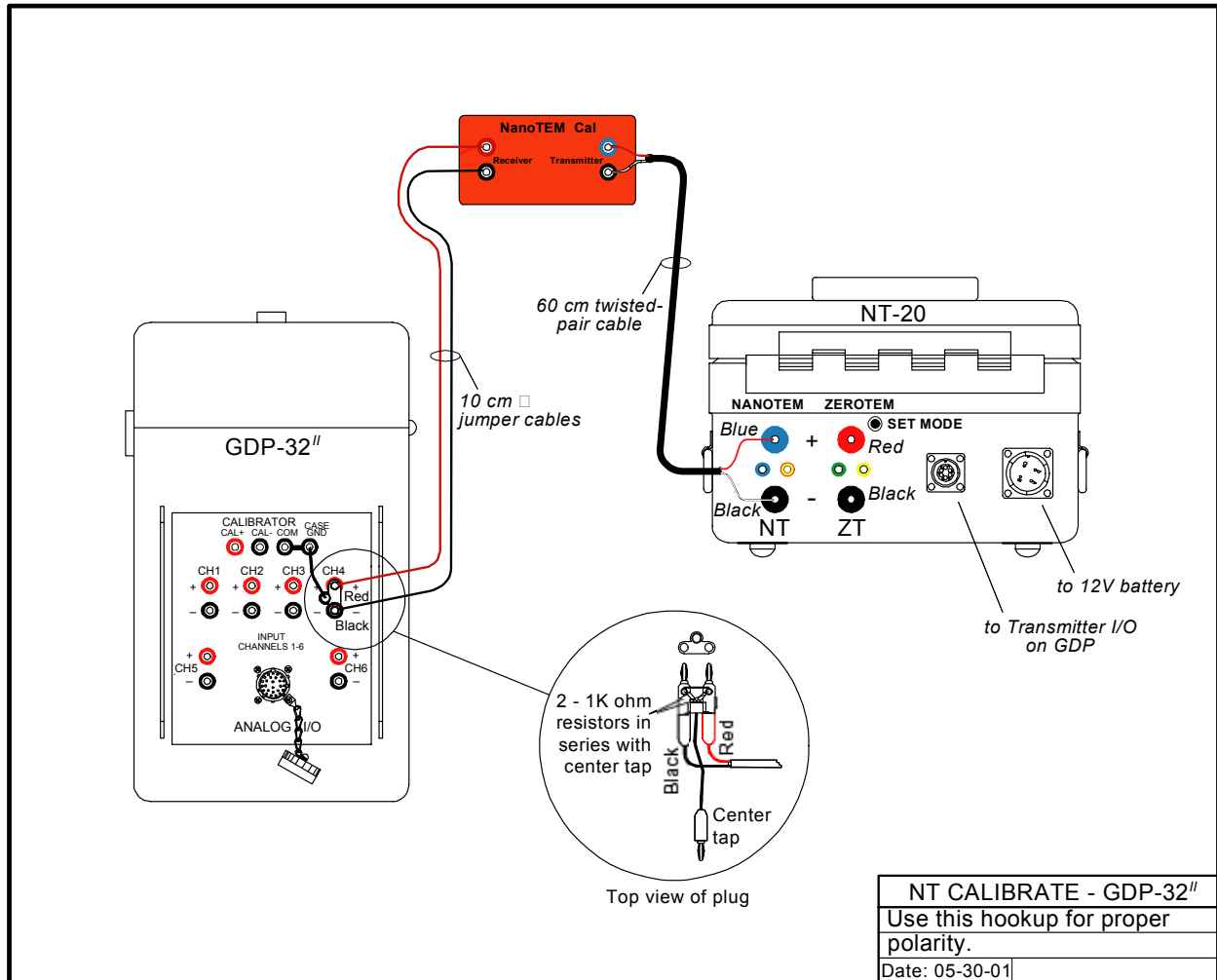
<u>SETUP</u>

Refer to the ***NT-20 NanoTEM Calibrate Setup*** schematic diagram showing the setup for testing the GDP-32^{II} with the NanoTEM Calibrate Box. Refer to ***Section 12.3*** to set up the correct header information for TEM. Follow the steps enumerated below and refer to the figure:
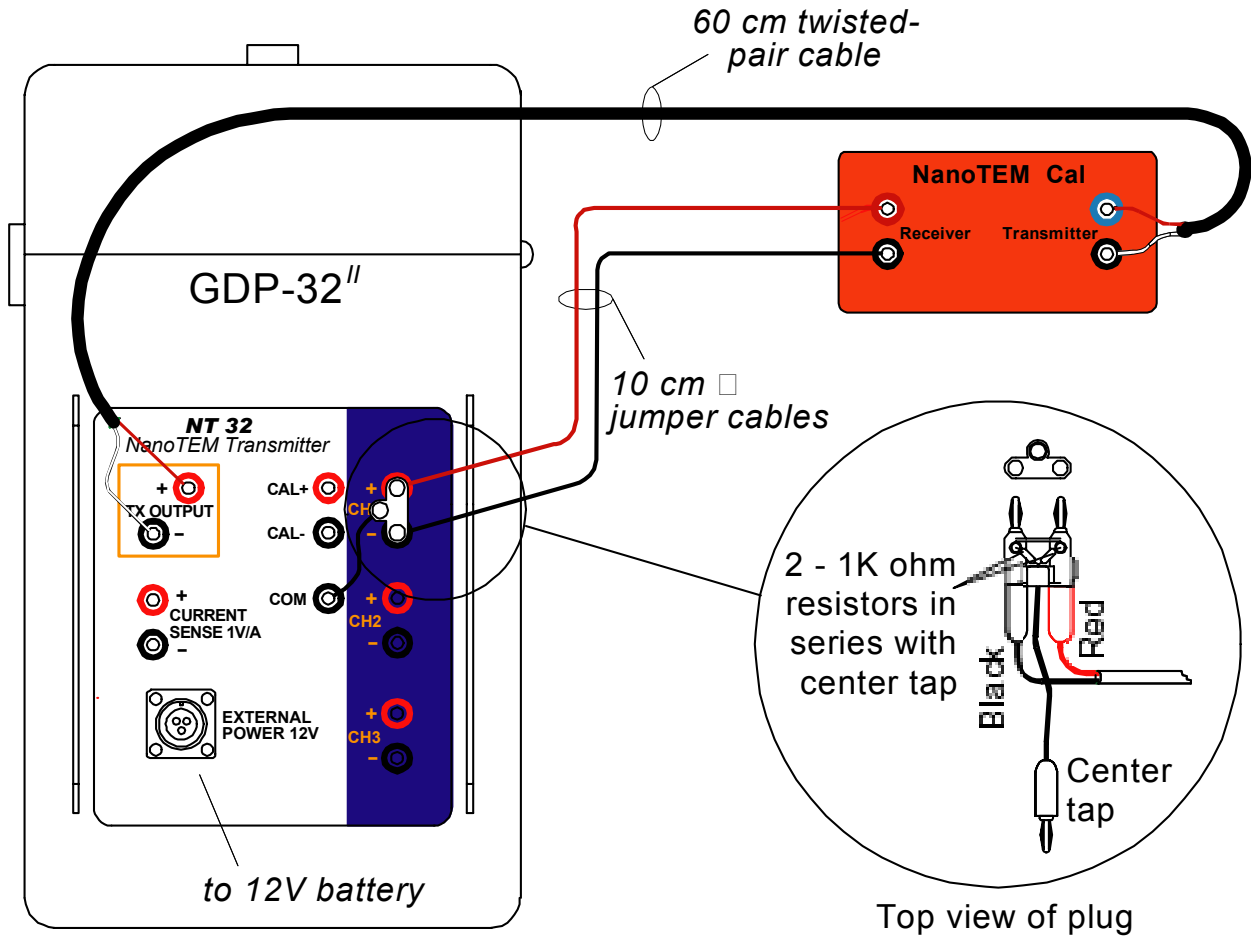
1. Connect the NT-20 transmitter outputs to the corresponding TRANSMITTER jacks (**BLUE** and **BLACK** banana jacks) of the NanoTEM Calibrate Box. Use the 60 cm twisted-pair cable provided with the calibrate box.

2. Plug the NT-I terminal connector (i.e., black double banana plug with single banana plug pigtail cable) into a GDP-32^{II} input channel corresponding to a NanoTEM analog card. Plug the pigtail into the **COM** jack of the GDP-32^{II}.

3. Connect the RECEIVER outputs of the NanoTEM Calibrate Box to the input channel containing the NT-I terminator plug, **RED** to **RED** and **BLACK** to **BLACK**. Use 10 cm jumper cables.

4. Connect the NT-20 power cable to a 12Vdc power source and the Transmitter I/O cable from the GDP-32^{II} to the corresponding cable connector on the NT-20.

5. The results plotted in the ***NanoTEM Calibrator Decay Transient*** figure show the transient curve for 1.2 µs sampling and 1.6 µs sampling, respectively with the antenna delay set at 2 µs and the Tx delay set at 1.5 µs. The ALIAS filter was set to **IN**. The receiver moment was set for a standard 5mx5m loop (RxM = 250). The output current of the transmitter should be adjusted to 1 A.

The recorded signal levels are normalized by current so it is important that the output current be set to one amp if decay curves are to be compared to those in the figure. Also remember that you are comparing curves with the same total delay time.

NT-20 NANOTEM CALIBRATE SETUP

NanoTEM Cal

Receiver   Transmitter

60 cm twisted-
pair cable

NT-20

10 cm
jumper cables

GDP-32^{II}

NANOTEM   ZEROTEM

Blue   ●SET MODE

+   Red

Black   -   Black

NT   ZT

to 12V battery

to Transmitter I/O
on GDP

CALIBRATOR   CASE
CAL+ CAL- COM   GND

CH1   CH2   CH3   CH4
+   +   +   +
Red
-    -   -   -
Black

INPUT
CHANNELS 1-6
+   +
CH5   CH6
-    -

ANALOG I/O

2 - 1K ohm
resistors in
series with
center tap

Black   Red

Center
tap

Top view of plug

NT CALIBRATE - GDP-32^{II}
Use this hookup for proper polarity.
Date: 05-30-01

NT-32 NANOTEM CALIBRATE SETUP

60 cm twisted-pair cable

NanoTEM Cal

Receiver   Transmitter

GDP-32^{II}

10 cm jumper cables

NT 32
NanoTEM Transmitter

+
TX OUTPUT
–

CAL+

CAL-

+
CH1
–

+
**CURRENT
SENSE 1V/A**
–

COM

+
CH2
–

**EXTERNAL
POWER 12V**

+
CH3
–

to 12V battery

2 - 1K ohm resistors in series with center tap

Black   Red

Center tap

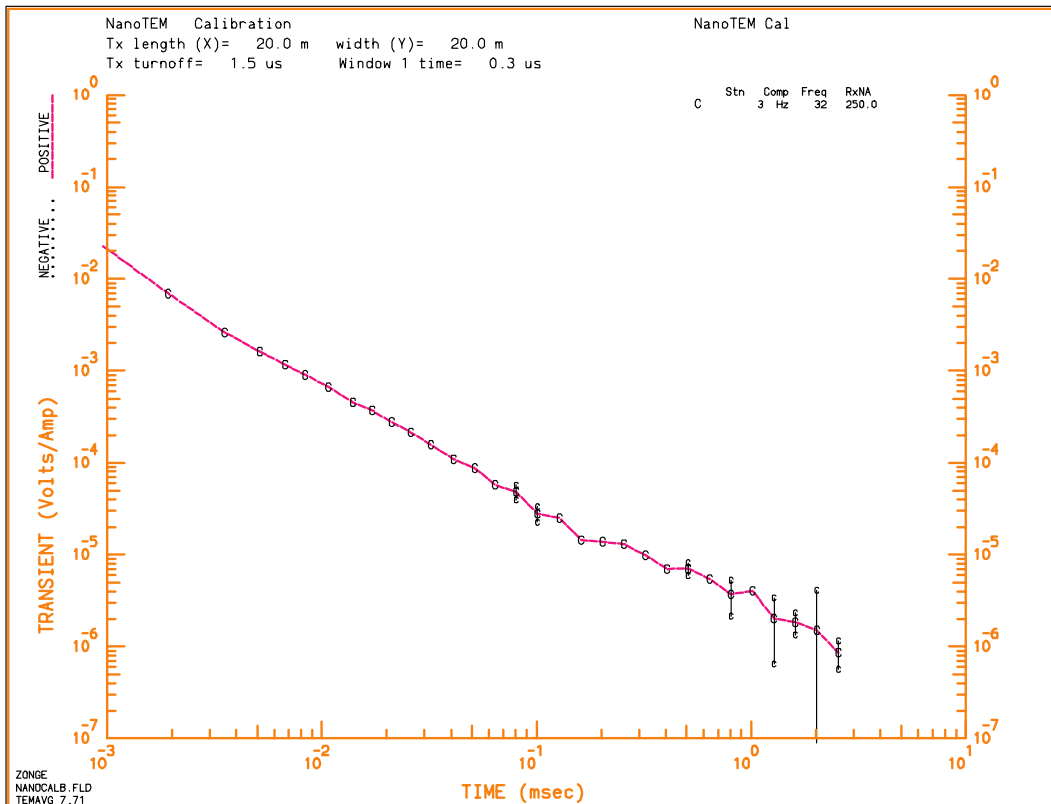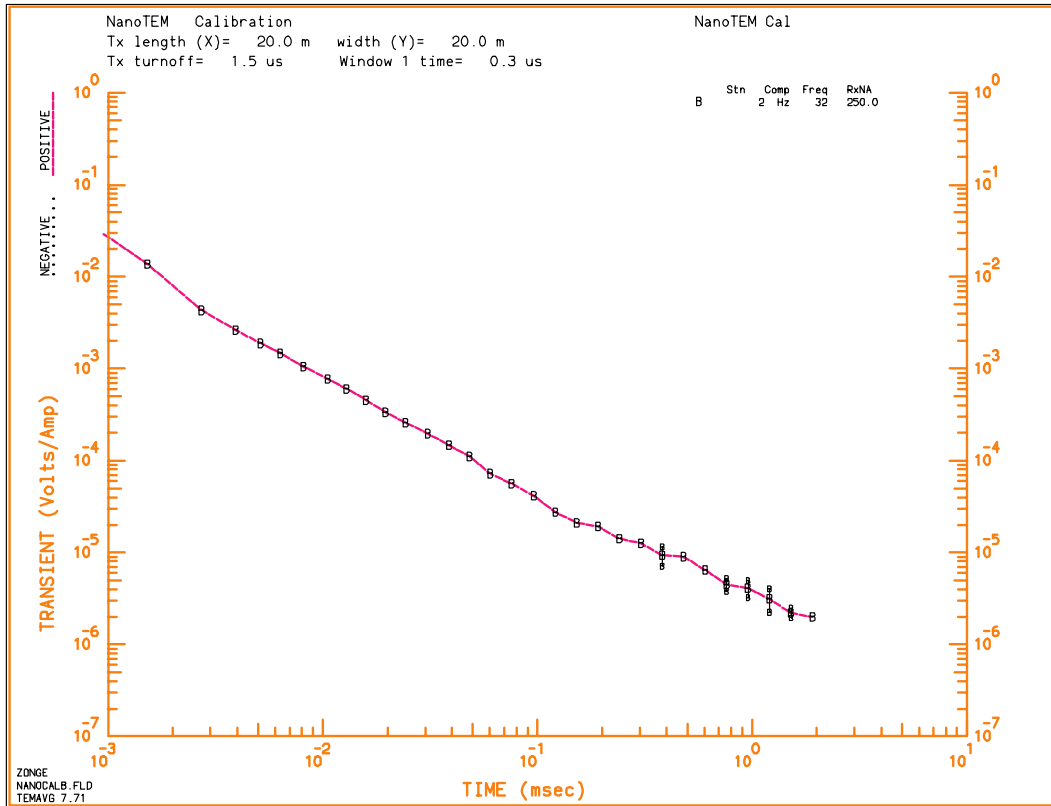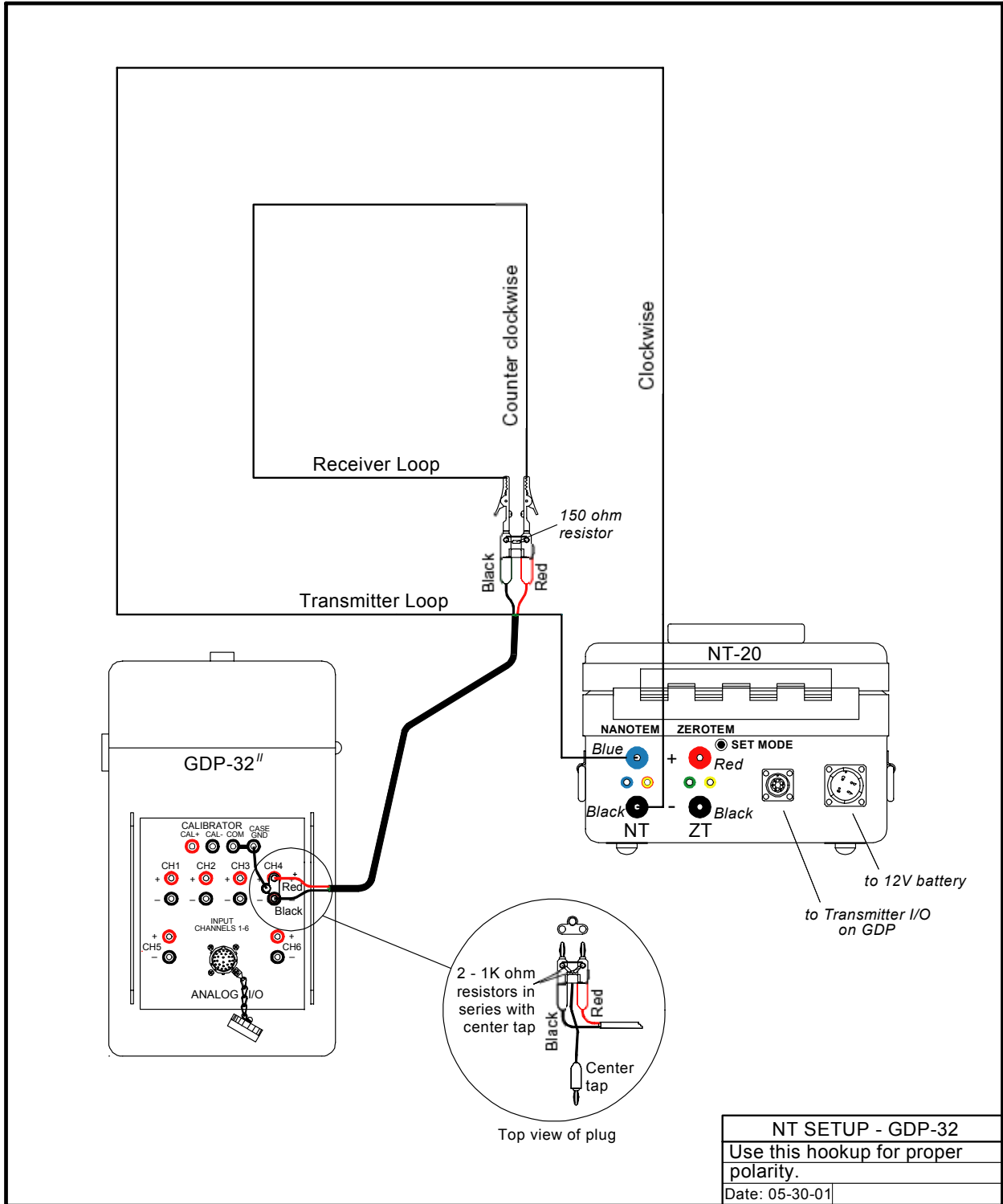Top view of plug

NANOTEM CALIBRATOR DECAY TRANSIENT

A (top): 1.2 us sample interval, *B* (bottom): 1.6 us sample interval.

12.26   NANOTEM FIELD SETUP

NT-20 FIELD SETUP

Counter clockwise

Clockwise

Receiver Loop

150 ohm resistor

Black   Red

Transmitter Loop

NT-20

NANOTEM   ZEROTEM

SET MODE

Blue

+ Red

Black

Black

NT   ZT

GDP-32^{II}

CALIBRATOR   CASE
CAL+ CAL- COM   GND

CH1   CH2   CH3   CH4
 +   +   +   +

 −   −   −   −

Red

Black

INPUT
CHANNELS 1-6

CH5 +   CH6 +

 −   −

ANALOG I/O

to 12V battery

to Transmitter I/O
on GDP

2 - 1K ohm
resistors in
series with
center tap

Black   Red

Center
tap

Top view of plug

NT SETUP - GDP-32
Use this hookup for proper polarity.
Date: 05-30-01

NT-32 FIELD SETUP

12.27 EQUAL-INTERVAL MODE, NANOTEM

General

A version of the NanoTEM program that runs on the Zonge GDP-32^{II} receiver permits NanoTEM transients to be uniformly sampled and stored as time series to the hard disk. The window parameter may be toggled between **ZONGE STANDARD**, **SHALLOW** and **EQUAL INTERVAL** acquisition modes. The **ZONGE STANDARD** NanoTEM data acquisition modes are described in the NanoTEM sections of this manual. When the NanoTEM program is operating in the **EQUAL INTERVAL** mode, it writes **EQUAL** in the window parameter field in the data cache.

The program stores the first 31 samples of the transient time series to the data cache using a format identical to that of the NanoTEM program. However, the entire transient waveform that usually contains many more samples is written to a disk file whose name is **BLKnnnn.NTE** where **nnnn** is a 4-digit integer corresponding the GDP32^{II} block number of the data measurement. The transient data files are written in binary for efficient storage and data transfer. But they are easily transformed into ASCII text format using one of DOS executable utilities furnished when a receiver is purchased with this version of the NanoTEM program.

The NanoTEM Equal Interval program can handle a maximum of 65536 bytes of data. Since each sample point takes 4 bytes, the maximum number of sample points that can be acquired is 16384. Divide this number by the number of channels to determine the number of samples per channel that can be acquired.

Operating Instructions

With a few minor differences as explained below, the **EQUAL INTERVAL** NanoTEM program operates the same as the NanoTEM program.

MENU 1:

Select the **EQUAL INTERVAL** option by moving the cursor to the **WINDOWS** field and toggling between **EQUAL INTERVAL**, **SHALLOW**, and **ZONGE STANDARD** options. The remaining parameters are the same as in the standard NanoTEM program.

MENU 4:

In MENU 4 (the last menu before data are acquired) there are three parameter fields:

Width: This field is set to a sample interval of 1.2 µs.

Start: This field specifies the delay time in sample intervals from the logic time of current turn-off to the first sample of the transient. No corrections for transmitter delay filter delays antenna delays, or current turnoff times are applied. Delays of 1 through 99 are permitted.

Count: This field specifies the number of samples to be acquired. The maximum number of samples is 4096.
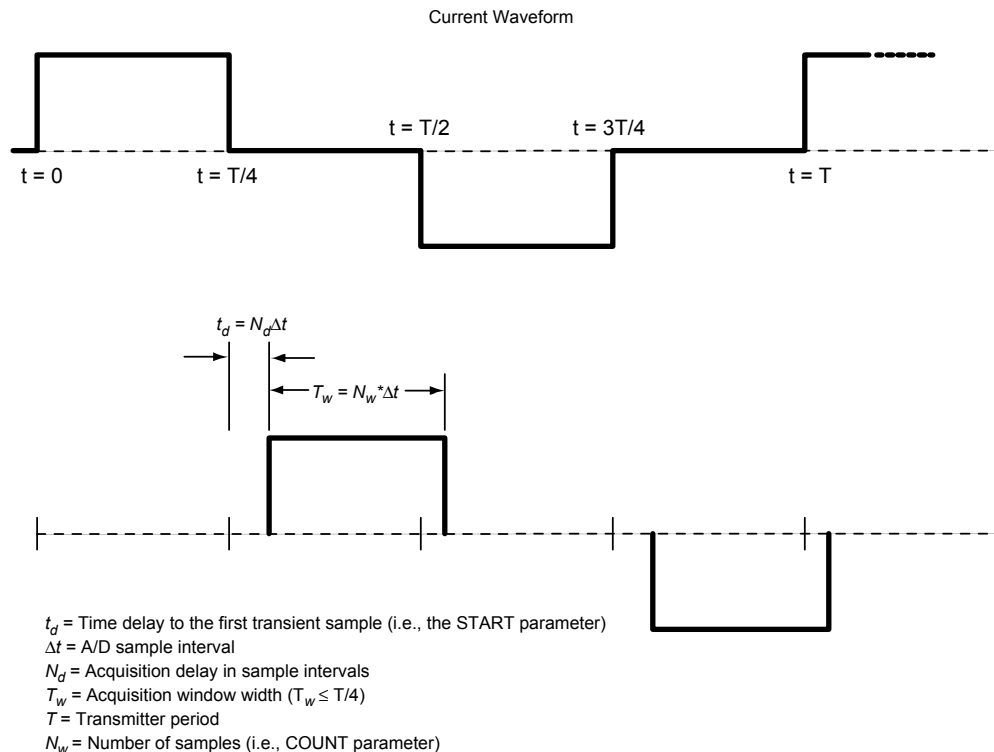
Data Inspection and Downloading

The sampled data falling within the gates as defined above and illustrated in the accompanying figure are rectified and stacked. These data are stored both in the data cache and as binary files on the hard disk. Only the first 31 data points are stored in the cache. They may be viewed and/or dumped from the DATA menu using procedures common to all the programs. The binary files are stored on the hard disk with the name `BLKnnnn.NTE`, where `nnnn` is an integer corresponding to the block number of the corresponding partially complete data set stored in the data cache.

The binary data may be downloaded using either the LAN connection or the serial port. The steps for downloading are listed below:

1. While the GDP-32^{II} power is off, connect it to either a LAN or to the serial port of another computer (a null modem must be used).
2. Turn on the GDP-32^{II} and run Windows.
3. If using the LAN, you may have to re-configure the network parameters in the GDP-32^{II} to be compatible with your network.
4. If using the serial port, HyperTerminal is the recommended program to use. You will have to ensure that the two serial ports are configured identically.
5. The data files are stored in `d:\data\`.

Binary data files with the extension `.NTE` may be inspected by converting them to ASCII format. The utility program `TEMASCII.EXE` converts a binary file to an ASCII text file of the same name with extension `PRN`.

The source code for this utility program is included so that users or customers have prototype C code for reading a binary file containing uniformly sampled transient data.

Current Waveform

$t_d = N_d\Delta t$ = Time delay to the first transient sample (i.e., the START parameter)
Δt = A/D sample interval
N_d = Acquisition delay in sample intervals
T_w = Acquisition window width ($T_w \le T/4$)
T = Transmitter period
N_w = Number of samples (i.e., COUNT parameter)

Explanation of the EQUAL INTERVAL mode data acquisition mode in the GDP-32^{II} TEM program