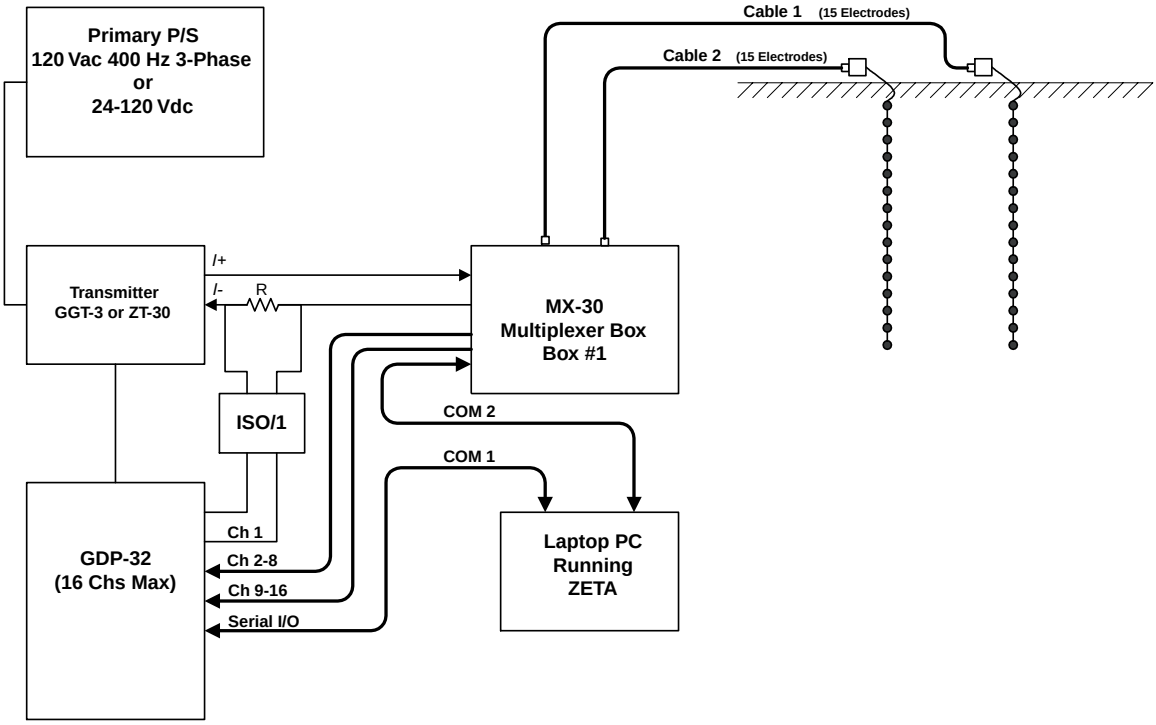
ControlMxGdp (ZETA)

General Description

The program "ControlMxGdp" (ZETA), is a Zonge proprietary Windows 95/NT-based application program that controls the acquisition of electrical resistivity data using the MX-30 multiplexer box together with the GDP-32 multi-function receiver with LLL-32 v204q EPROMs installed. This software, together with the necessary pieces of hardware has been developed to facilitate the acquisition of electrical resistance tomography (ERT). Figure 1 is a functional block diagram showing a typical field system for ERT surveys.

Computer Requirements – ZETA can be run on any computer platform that supports Windows-95/NT, has a minimum of 8 MB of RAM, a hard disk, and two (2) serial ports. As suggested in Figure 1, the program is typically installed on a laptop computer.

Functional Description – Under control of ZETA, the laptop computer controls the acquisition functions of the GDP-32, and the configuration of MX-30 through serial COM ports assigned to each device. ZETA can be operated in a manual mode that permits the operator configure the MX-30 for a desired transmitter electrode pair and to connect up to 16 receiver channels (32 connects) to electrodes not connected to the current lines. Similarly, once connections have been made, the operator can manually command the GDP-32 to measure each of the connected signals using either the frequency domain program (RPIP) or the time domain program (TDIP) of the GDP-32. Normally, however, the operator will open a preprogrammed list of MX-30 configurations, called a ***schedule*** and then set ZETA to operating in its automatic acquisition mode. The MX-30 is configured automatically to each of the desired electrode configurations and data are acquired with the GDP-32. The measured data from the GDP-32 are transmitted to the control computer and stored in an ASCII text file on its hard disk. ZETA has the capability of generating simple dipole-dipole electrode schedules. Complicated schedules must be assembled by the end-user either with a special computer program or directly with a text editor.



ERT system block diagram showing functional relationships of major components. In this diagram, electrode strings are shown in boreholes. One or both of the electrode strings could lie on the surface as well.

Figure 1. ERT System Block Diagram

Program ControlMxGdp Notes. Version 1.16.

1. Installation (Windows 95/98 machine assumed)

1.1. Create a folder.

1.2. Copy the program ***ControlMxGdp.exe*** from the distribution diskette to the new folder. Copy ***mfc42.dll*** to the ***System*** subdirectory of the ***Windows*** subdirectory (typically ***C:\Windows\System***). To add the program to the program list follow the standard windows procedure. That is, right-click on the ***Start*** button. Then click on ***Open*** and "drag" the program icon into the desired group or folder.

1.3. Connect the host computer to the MX30 and the GDP32 then start the program.

A dialog-box titled "OFF" or "ON" will appear. The text in the box is ***EnablePowerManagement*** and the title describes the state of that entry in the Windows ***Registry*** when the program is started. **ControlMXGdp** turns power management off while it is running. It will restore the host computer to its original state upon exit. In the event that the program exits due to a fault condition, the initial power management state can be restored by editing the registry value.

"***EnablePowerManagement***" in key
"**HKLM\System\CurrentControlSet\Services\VxD\VCO**MM".

Click the ***OK*** button or press the ***Enter*** key to close the dialog-box. Next, click the ***Ports*** menu bar entry or press "***Alt+P***". A drop-down menu will appear with entries "**Gdp32**", "**MX30**" and "**Switch**". Clicking on either of the first two will cause the COM port assignment to be displayed. If these are not consistent with the connections that have been made, either change the connections or click "**Switch**". Clicking on "**Switch"** will switch the COM port assignments. In the latter case, it is best to stop and restart the program.

1.4. Click the "**FindMX30**" menu-bar selection. A dialog-box entitled "**Find MX30**" with four pairs of check boxes will appear. Each pair of check boxes represents a distinct MX30 address and as the program queries each address for a response, a check mark will appear in the "yes" box if a response is received, or in the "no" box otherwise. Typically MX30's are manufactured with the "box1" address. If one and only one "yes" box is checked, there is a communications problem. In any case, click on the "OK" button when all pairs of check-boxes have either a "yes" or a "no" box checked.

It is possible to send individual commands to the MX30 by clicking on the "Test" menu-bar selection and then on "MX30", then on the command and finally on the box to address. Attempting to send a command to a non-existent MX30 will cause a dialog-box, entitled "**Box*n***", where ***n*** is 1,2,3 or 4, with message text "**ERROR:MX30 no response**" to appear.

After the MX30 is responding, select **Test->TestGdp32->InitGdp32**. This will normally cause the **Gdp32** to initialize. Next select **Test->TestGdp32-**

>Gdp32Command->Prog->(Rpip or **Tdip)**. The Gdp32 will produce an audible beep if this command is successful. If there is no beep, there is a problem with Gdp32 communications. The Gdp32 display should reflect the mode selected.

1.5. Select "**Set Mx30 Timeout**" and make sure the timeout is 2500 milliseconds.

1.6. Select "**Mode**". In normal operation, none of the entries in the drop-down menu should be checked. The "**MX30 Checkout**" is only used in manufacturing.

The "**MX30 optimal switching**" entry will cause the transmitter schedule to be sorted in order to minimize the number of commands sent to the MX30. While this mode saves time, the sorting changes the order in which the transmitter and receivers are read. In its Landfill characterization surveys, Zonge has found that in order to measure good IP values, a given electrode pair should be used as a transmitter only after it is no longer needed as a receiver. **MX30 optimal switching** will shuffles the order in which a particular measurement appears.

The "**Debug**" mode causes the program to poll the MX30 for its actual electrode connections. This mode increases the MX30 setup time. In normal operation, the program saves a simulated response from the MX30.

1.7. The "Create Schedule" menu-bar entry can be used to create a simple schedule of transmitter-receiver pairs. This procedure doesn't work correctly if the transmitter length is greater than the unit transmitter-receiver separation.

2. Operating Instructions

2.1. Start the program from the Windows Explorer or the task list.

2.2. "File" and "Open", then select the schedule file of the electrode array(s) for data acquisition. A sample schedule is included in this distribution. A record from that schedule is shown below.

TX+01,TX-02,RX16,01,RX17,02,-01,RX18,03,-02,RX19,04,-03,RX20,05,-04,RX21,06,-05,RX22,07,-06,RX23,-07

The fields are comma delimited. The first field is the electrode for transmitter positive electrode and the second is the negative electrode. The third field identifies a receiver electrode and is followed by a GDP32-channel number field. A receiver electrode can be followed by as many as 16 channels. A "-" preceding a channel number indicates the channel low or common input. Each channel should be connected to two different electrodes and must NOT be connected to ANY transmitter electrode.

2.3. The transmitter and receiver pairs will be shown in the lower half of a splitter window and the operator will be prompted for the unit electrode spacing in meters.

2.4. Set the **Parameters->Acquisition** values "**Program**", "**Array**", "**Frequency**", "**Cycles**" and "**Repeats**". Note that "**Cycles**" is the number of periods of the "**Frequency**" that are averaged per repeat. ***Users of "LLL-32 L204" eproms MUST NOT check the "Get Windows" check-box.***

2.5. Set the **Parameters->GDP32** values "**Gains/Filters**", "**Notch/Filters**" and "**AutoGain**" as required. Note that, for a given schedule file, at least one run must have been made with "**AutoGain**" **ON** before any runs can be made with "**AutoGain**" **OFF**. The "**AutoGain**" **ON** run saves a file containing gain information for subsequent AG-Off runs. ***Users of "LLL-32 L204" MUST NOT check the "FastAutoGain" check box.***

2.6. Set the **Parameters->Transmitter Current**. Normally the "**Current Shunt**" box will be checked. In this case the shunt resistance value must be entered in the edit control below the check box.

2.7. Set the **Parameters->Assign GDP32 Channels**. If channel 1 is used as the current monitor, the channel type MUST BE "**TxI**". All other channels used in one or more of the transmitter schedule entries must be of type "**ON**".

2.8. Select the "**Start**" option under "**Control**" to begin data acquisition. The program will first acquire data from the GDP32 to confirm that a good communications link exists. It will then confirm the MX30 communications link. After completing the communications checks, the user is prompted for the name of the output data file. Only the name is required. The program will automatically assign "**raw**" as the extension. At the conclusion of the run, reformatted data will be written to a file with extension "**zrt**".

3. Known bugs

- After acquiring data, close the program and restart it for the next data acquisition run. The program sometimes hangs up when restarting from within the program

ControlMxGdp v2.12 Notes 07-21-00

I. Scope

A. These notes apply to ControlMxGdp v2.12 as used to control the Zonge Gdp32II receiver with executable Gdp32Zrt, v6.17.

B. These notes describe the topics listed below.

(1) The operator interface to the program
(2) File naming convention
(3) Quirks and known bugs
(4) Differences with respect to v1.04, etc

II. Operator interface.

A. The initial bar menu

(1) File

(i) Open
Selection of this entry causes a file open dialog to be displayed. The default extension is “sch” and is used for files containing the switching “schedule” for a single resistivity tomography data capture episode. When the schedule file is opened, the main window is overlaid by a splitter window that shows the schedule entries in the lower pane. The bar menu is also changed to the “Data capture bar menu”.

(ii) Raw to zrt
This selection allows the user to generate a *.zrt file from a *zrw file. A pseudo-section is also plotted.

(iii) Plot Pseudo-section
This selection allows the user to plot a pseudo section from a specified raw data file. Under V1.10, the pseudo section plot can be either a “property”, resistivity, phase or chargeability or a ratio of values from reciprocal measurements.

(iv) MRU section
The section immediately below the “Open” entry contains a list of the most recently used files. Typically files with extensions “sch” and “zrt” will appear. Only the “sch” files should be selected.

(v) Exit
Self explanatory.

(2) FindMX30
Selection of this menu item causes a dialog box entitled “Find MX30” to pop up. This dialog box has a pair of yes/no check boxes for each of four MX30 boxes, numbered 1 through 4. As the search progresses, a yes or no box is checked for each box. If at the conclusion of the search only “no” boxes are checked, no MX30 was found. Data capture cannot proceed until this situation is rectified.

The “OK” button should not be clicked until the search is finished. If the dialog box is closed prematurely, the program should be stopped and restarted to avoid unpredictable behavior.

Finally, it should be noted that this program does not support the use of multiple MX30 boxes at this time. This function is provided because some MX30 boxes may be have a number other than “1” internally.

(3) Test
Selection of this item causes a pop up menu with entries “TestGdp32” and “TestMX30” to appear. Selection of either of these causes yet another pop up menu to appear.

TestGdp32

Virtually all Gdp32 remote functions can be tested with this selection. First select “Init Gdp32”, then “TestGdp32”->”Gdp32 Command”->”Prog”->”Rpip” or ...->”Tdip”. The Gdp32 should emit an audible beep in response to this command. If no beep, there is a problem which should be rectified before proceeding.

If the “Prog” command elicits a beep from the Gdp32, next go to “TestGdp32”->”Gdp32 Command”->”Channels”. This causes a dialog box with Gdp32 channel status to appear. Make sure at least one channel is ON. Otherwise some commands will seem not to work.

At this point, most commands should work. The ones listed below may be of particular interest.

“TestGdp32”->”MoreGdp32 Cmd”->”Frequency”
- Sets fundamental frequency.

“TestGdp32”->”MoreGdp32 Cmd”->”#Cycles”
- Sets number of data capture cycles.

“TestGdp32”->”MoreGdp32 Cmd”->”Data”
- Does a data capture

TestMX30

Selection of this item leads the operator through a chain of pop up menus. The last pop up in the chain is the same in all cases and it has four entries, "Box1", “Box2”, “Box3”, and “Box4”. If a box has been found, it is checked. Selection of any but the checked item here will probably end in failure.

The beginning of the pop up chain is another menu which has 4 items, “Disconnect”, “SetTx”, “SetRx” and “Who”. Selection of “Disconnect” pops up yet another pop up with 2 items, “Transmitter” and “Receiver”. Selection of either of these leads to the box menu and selection of the checked item there causes all transmitter or receiver electrodes to be disconnected.

The “SetTX” selection pops up the box menu which then, pops up a dialog box which allows the user to choose the MX30 electrode numbers for the anode and cathode. Anode is taken to mean positive or “+” here.

The “SetRx” selection pops up the box menu which then pops up a dialog box inviting the user to select a Gdp32 channel and the MX30 electrodes to be attached to it.

The “Who” selection pops up the box menu which then, after several seconds, pops up a dialog box showing the MX30 electrode connections.

(4) Create Sched

When selected, this item pops up a menu with items “Single Electrode Array” and “Dual Electrode Arrays”. Selection of the first causes a dialog box to appear which allows the user to select the number of Gdp32 channels (1 through 16) and the n-spacing (1 through 5). When the “OK” button is clicked, the program generates a schedule and prompts the user for a file name.

The dialog box, produced in response to selection of the “Dual Electrode Arrays” item, differs from the one described above only in that it has (1) a check box allowing the user to opt for inclusion of reciprocal transmitter-receiver pairs, and (2) a pair of check boxes by which the user can elect to have the transmitter bipoles on the array of electrodes 1 through 15 or the array 16 through 30.

The schedule is generated with the assumptions listed below.

(1) Gdp32 channels are contiguous.
(2) Gdp32 channels start at 1.
(3) The specified number of Gdp32 channels does not include the transmitter current monitoring channel.

(4) The transmitter and receiver bipoles can overlap.

(5) Set MX30 Timeout

This item pops up a dialog box that allows the user to set a timeout value for the MX30. This value is used in two ways. During normal data capture it is used as a timeout value for communications with the MX30. In MX30 checkout mode (see Mode under Data capture bar menu) it is used as the interval delay between consecutive MX30 configurations.

(6) Ports

This item pops up a menu that allows the user to set the Comm ports for the Gdp32 and the MX30. These ports should be set before any commands are sent to either device. To change the ports after commands have been sent, the program should be stopped and restarted.

(7) Mode

This menu item has three items in its submenu, “MX30 Checkout”, “MX30 optimal switching” and “Debug”. The first is used for factory QC of MX30 boxes and is normally of no use to field users. When checked, it disables communications with the Gdp32 so the MX30 can be cycled through the configurations specified in the “sch” file without need for a Gdp32.

When “MX30 optimal switching” is not checked, switching between consecutive configurations of the MX30 is done by simply disconnecting all transmitter and receiver electrodes and then connecting those specified in the next schedule entry. When that item is checked, before any switching is done, the next configuration is compared to the one preceding it and only differing electrode pairs are switched. Considerable time savings can result.

If “MX30 optimal switching” is checked when the “sch” file is opened, the user will able to choose whether or not to “sort” the “sch” file. If he elects to do so, the schedule will be rearranged to minimize the number of differing electrode pairs between adjacent schedule entries. When the schedule has been sorted the user can save it with a new file name.

“Sorting” is slow. A schedule for all possible transmitter pairs (29) with 7 receiver channels has about 120 entries and takes more than 30 minutes to sort on a P5-100 under Windows NT v4.0. But the run-time for such a schedule is half the runtime for an unsorted schedule.

The “Debug” option causes the program so synthesize the “who” response from the MX30, saving some time.

B. Data capture bar menu

(1) File

This item pops up a menu with items “Close”, “Save”, “Save As”, a MRU list and “Exit”. “Close” causes the currently open file(s) to be closed. Invoking “Close” while data capture is in progress could result in abnormal program termination with loss of data. “Exit” stops the program.

“Exit”ing during data capture could also have undesirable results.

“Save”, “Save As” and the MRU list should not be used.

(2) Control

This item pops up a submenu with items “Start” and “Stop”. The former starts data acquisition with the schedule shown in the lower half of the splitter window. The latter can stop data capture before the end of the schedule is reached.

(3) Parameters

This item pops up a submenu with items “Acquisition”, “GDP32”, “Transmitter Current”, “Assign GDP32 Channels”, “Find MX30 Box” and “Set MX30 Box”.

The “Acquisition” item allows the user to set the array type, the fundamental frequency and the number of cycles per capture.

The “GDP32” item allows the user to set the modes for the Gains/Filters, the Notch Filters and Autogain.

The “Transmitter Current” item allows the user to set the current determination method to either (1) constant value or (2) monitoring of a current shunt resistance and to set the value of the current in the first case or the shunt resistance in the second. Note that the first constant current method is not implemented at this time.

The “Assign GDP32 Channels” item allows the user to set GDP32 status. This status should be “OFF”, “ON” or “TxI”. The latter indicates that the channel is on but is used to monitor transmitter current and not, therefore, available for data capture.

The “Find MX30 Box” performs the same function as the FindMX30 bar menu item described above.

The “Set MX30 Box” item allows the user to specify the active MX30 box. It should not be used unless the internal box number of the MX30 is known.

III. Other

A. Editing a schedule

Right-clicking on a schedule line allows the operator to either delete or edit that line.

IV. File naming convention

A. File extension “sch”

This file extension is used for the MX30 switching schedule as stated above. Entries in this schedule consisted of CRLF terminated lines of text. Each line consists of a transmitter bipole definition followed by a set of receiver bipole definitions.

An example transmitter bipole definition is shown below.

TX+01,TX-04,

The meaning of this definition is that MX30 electrode 1 is connected to the “positive” transmitter output and electrode 4 is connected to the “negative” transmitter output. The trailing comma separates this string from the receiver definitions which follow.

Examples of receiver bipole definitions are shown below.

RX03,-3,

RX05,02,-4,

The RXnn part of this definition is the MX30 electrode number. The following number(s) is/are the Gdp32 channel to which the electrode is connected. The minus sign indicates the "negative” channel input. Each channel must have an entry for both the positive and the negative input. The electrode-channel assignments may appear in any order within the line of text, except that the transmitter definition must be at the beginning of the line.

Some typical schedule entries are shown below. Note that in the first example the line wrap is caused by formatting of this text, NOT by an embedded CRLF.

(1) TX+01,TX-04,RX02,-2,RX03,-3,RX05,02,-4,RX06,03,-5,RX07,- 6,RX08,04,-7,RX09,05,-8,RX10,06,RX11,07,RX12,08

(2) TX+01,TX-04,RX10,-2,RX11,-3,RX12,-4,RX13,02,RX14,03,RX15,04

B. File extension “zrt”

This file extension is used for the data captured by the program. During data capture it contains the raw text received from the MX30 and the Gdp32. At the conclusion of data capture the file containing the raw data is given the extension “raw” and a new “zrt” file, containing reorganized and reduced data, is written.

V. Quirks and known bugs.

A. Initial bar menu

(1) Test

(i) TestGdp32 No error indication is returned if the Gdp32 does not respond. This behavior is partially ameliorated by the fact that the Gdp32 generates audible output for many commands. For instance, "TestGdp32"->"Gdp32 Command"->"Prog"->"Rpip" or ...->"Tdip" causes the Gdp32 to beep.

B. Data capture menu

C. General

(1) If the program hangs at the "WAIT – Checking GDP32 comms" message, it will probably be necessary to reset the current monitor channel because it will have changed from type "TxI" to "ON".

(2) If overrun errors occur, it may help to reduce the FIFO threshold in the W95 Control Panel->Device Manager->Ports->Com1 and 2.

VI Differences with respect to v1.04

A. FindMX30 – This is fixed in V105, V106.

At the conclusion of the search for MX30 boxes, the message "MX30 no Response. Process ABORTED" may be displayed. This is of concern provided that one of the boxes is checked.

VII Differences with respect to v1.05

A. The zrt file data were scrambled in some cases. This is fixed.
B. The sequence number was not correct in V1.05. This is fixed.
C. It is now possible to restart the program without completely stopping it. Close ALL open files and then open the new schedule file. This is necessary even if the schedule file is the same as the last one run.

VIII. Differences wrt V1.06

A. Voltage and current phase are not displayed or saved for TDIP.
B. A blank was inserted between the last RX electrode and the first data field in the zrt file.
C. Commas replaced by blanks in output records.
D. Elapsed time and current setup number are shown on the optionally displayed status bar.

IX. Differences wrt V1.07

A. The "Mode" menu entry has been moved from the data capture bar menu to the initial bar menu.
B. The "Mode" drop-down menu has an additional entry, "Debug". When it is selected, the Who command is sent to the MX30 for every data capture event. Otherwise, it is not sent during data capture.

X. Differences wrt 1.08

A. A "Plot Pseudo Pseudo-section" entry has been added to the initial "File" drop-down menu. A pseudo-section plot is also generated in conjunction with the conversion of a raw file to a zrt file and at the end of a data capture episode. A third pane has been added to the data capture splitter to accommodate the pseudo-section plot. This is an apparent resistivity plot and the user is prompted for the a-spacing in meters before it is generated. This may be confusing at the end of a data capture episode because the pseudo-section plot pane is completely closed.
B. For TDIP, the absolute value of the current is used to compute V/I.
C. The notch and anti-alias filter settings have been added to the header.
D. The order in which active electrodes are "set" on the MX30 has been reversed to see if this makes the process faster. This only applies to non-optimized schedules.

XI Differences wrt 1.09

A. The pseudo-plot apparent resistivity calculation was corrected.

B. A pseudo plot of ratios of reciprocal values was added. On this plot, putting the cursor on a plot point causes the ratio, and the reciprocal values to be displayed.

X Differences wrt 1.10

A. Apparent resistivity pseudoplot still not correct.
B. Repeat capability finished.
C. The schedule file name was not found if the extension was upper case. This is fixed.
D. The "V/I" error message was deleted because it didn't really reflect an error.
E. Some code was added to protect the operator from over-writing an existing "zrt" file.
F. All MX30 "synchronize" commands except the very first for a given schedule entry were deleted. This seems to work and is appreciably faster.
G. The MX30 find box code was moved out of the capture data loop. The box is verified only at the very beginning of the loop. CMainFrame::OnCaptureData.
H. Code to clear and unfix gains and attenuation was moved into a function, CControlGdp32::ClearAndUnfixGains.

XI. Differences wrt 1.11

A. Modify the condition for switching to Mode3 data capture so that the Mode1 SEM calculation is done for 13 GDP32 channels. This is done to the GDP32 code called zrt 204t. Now SEMs are non-zero for 0.5 Hz, 8 cycles. No mod required to ControlMxGdp.
B. Modify both programs to output/receive the 13 windows of integrated transient values for each GDP32 channel.
C. Add hardware handshaking to both progs. I'm not sure this is working.
D. In StopDataCaptureSequence, add wait for OrganizeData thread to finish.
E. Add support for an autogain only computer control function to both programs. This would allow autogaining at 8Hz then acquiring data at 0.5 Hz.
F. Add ControlMxGdp version to the header. This requires function CAboutDlg:GetVersion to get the version from the CAboutDlg.

XII. Differences wrt 1.12

A. Pseudosection resistivities corrected. They were low by a factor of 10, division by 10,000 instead of 1000 to convert to ohm-m from milliohm-m.
B. Add channel dialog popup to Raw to Zrt menu function to make sure the correct channels are turned on when that conversion is done.
C. Change psect from "Normal-Reciprocal" to "Resistivity-SEM", "Chargeability-SEM" and so forth. Also change Chargeability scale so all values show.

XIII. Differences wrt 1.13

A. Change a-spacing to electrode spacing and make it persistent.
B. Make number of repeats persistent.
C. Change GDP32 communications check to use 8 Hz and 1 cycle.

XIV. Differences wrt 1.14

A. Increase size of buffer used in RewriteFile to prevent occasional skipping of repeat data.

XV. Differences wrt 1.15

A. All commands now handshake. The packet returned from the GDP32II is of the form STX<Cmd>,<Error Code>,<Data>ETX for a command packet of the form STX<Cmd>ETX.
    i. The initial comm check is now just to send the ARRAY command. If no response, an error.
    ii. Some timing had to be changed because response time outs were too short.
    iii. The GDP32II returns the cache block number and can, optionally, save results in the cache.
    iv. In void CControlMX30::BuildWhoResponse, skip the current monitor channel. This was causing the sequence number to be skipped. I don't know why it didn't cause

problems in V1.15.

B. Added commands
   i. Fast autogain. The GDP32II has built in the capability to autogain at 1 Hz if this parameter is selected.

XVI. Differences wrt 2.00

A. Scaling bug in gdp32zrt fixed.
B. New Control options added:
   i. Suspend – This option suspends the current schedule execution at the conclusion of the active line.
   ii. Resume – Resumes a suspended schedule.
   iii. Resume At – This option allows the operator to resume at a particular line of the original schedule. He may also resume with a sub-schedule (up to 10 lines in length).
C. Visual queues
   i. A field has been added to the status bar which describes the system state (idle,running or suspended).
   ii. A View has been added which shows the communications activity as two simulated LEDs. The lefthand one is for MX30 communications, the right for GDP32. When transmission from the host computer is in progress, the LEDs are red, otherwise they're green.
D. Two memory leaks were fixed in ControlMxGdp, module ControlMX30GdpDoc.cpp.

XVII. Difference wrt 2.10

A. Mods added to make restart after abort more reliable.
B. A "cancel" exit from the file open dialog causes an abort now.
C. Drop-down list boxes now used the list box value for the current selection when the list box is closed, i.e., it's no longer necessary to click the value shown in the list box to select it.
D. A blank line at the end of the schedule no longer causes a "TX+,0 TX-,0" entry in the schedule.
E. "switch"ing the com ports no longer causes the program to hang.
F. Repeat handling was wrong. Setting the number of repeats to 4 resulted in 8 actual repeats.
G. Negative resistivities are plotted in the pseudo-section plot.

XVIII. Differences wrt 2.11

A. Schedule generation glitch fixed.
B. Fix double electrode-spacing prompt.
C. Reset the MxGdpComm::bAbort variable before testing Gdp32 coms in OnCaptureData. That seems to fix the hang-up on abort during MX30 setup.

TECHNICAL NOTE

Measuring Contact Resistance with the ZETA System

GENERAL

In order to acquire useful ZETA data, it is essential that the contact resistance of each electrode in the cable string be as low as possible. Our present field procedure does not conveniently permit measurement of contact resistance of the electrodes. As a consequence, electrode problems are not discovered until after a schedule has been completed and viewed. Moreover, if the operator is not conscientious enough to preview the data from each spread in pseudo-section format before the cables are moved, it is often necessary to go back and repeat spreads.

The ZETA program can be used to run a single line electrode schedule. Upon canceling the schedule (as opposed to "Stop"ping), the MX-30 remains in the state called for by the last line of the schedule transmitted before cancellation. The operator can then go into TDIP or RPIP on the GDP-32 and manually execute CRES to measure contact resistance.

We have formulated two single-line ZETA schedules to run so that each cable in a standard 30-electrode ZETA spread can be systematically checked for the contact resistances of the 15-electrode cable. The electrode schedule files for cables 1 (electrodes 1-15) and 2 (electrodes 16-30) are, respectively, CRES_C1.SCH and CRES_C2.SCH. These schedules set up the MX-30 so that contact resistance can be measured using channels 2-13 of the standard GDP-32/13. Table 1 shows how the cables are tested using each schedule.

Table 1: MX-30 state for Manual Contact

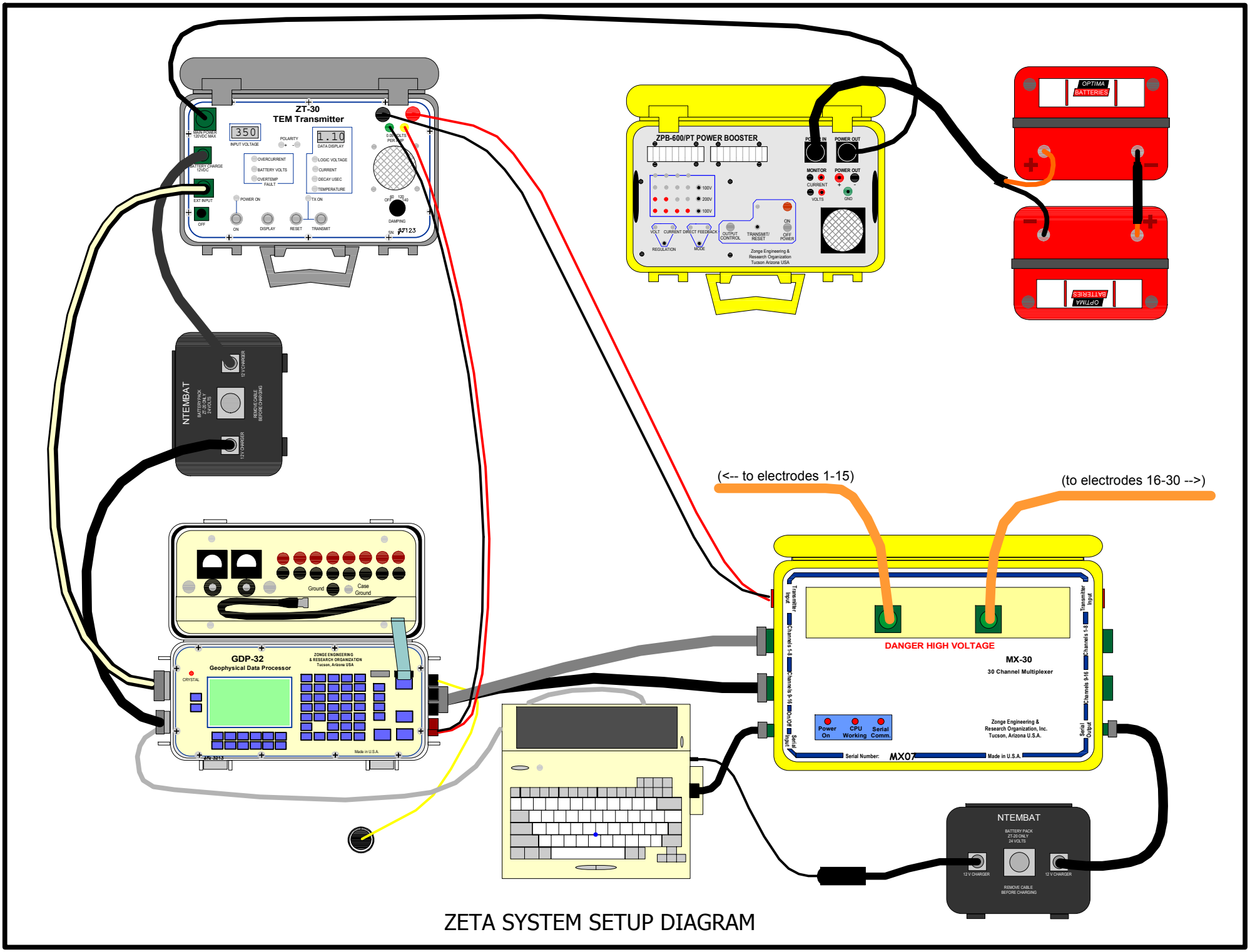
Rcvr Ch	CRES_CR1 Electrodes 1-15	CRES_CR2 Electrodes 16-30	Cable Takeout Number (1 - 15)[1]
1	N/A	N/A	N/A
2	(15,14)	(16,17)	(1,2)
3	(13,12)	(18,19)	(3,4)
4	(11,10)	(20,21)	(5,6)
5	(10,9)	(21,22)	(6,7)
6	(10,8)	(21,23)	(6,8)
7	(10,7))	(21,24)	(6,9)
8	(10,6)	(21,25)	(6,10)
9	(10,5)	(21,26)	(6,11)
10	(10,4)	(21,27)	(6,12)
11	(10,3)	(21,28)	(6,13)
12	(10,2)	(21,29)	(6,14)
13	(10,1)	(21,30)	(6,15)
TX	(29,30)	(1,2)	

[1] The takeout number is numbered from near (1) to far (15). Thus the two schedules provide identical measurements for their appropriate cables provided we number by the takeout method from takeout nearest the center (1) to the takeout farthest away (15).

PROCEDURE

1. Shut the transmitter down. Press RESET on the ZT-30. Note that ZETA requires that two electrodes be setup as transmitter electrodes. If you run one of the single-line CRES schedules, therefore, and the transmitter is in the TRANSMIT mode, the transmitter electrodes will be hot whenever the DUTY CYCLE signal (one of the Transmitter I/O logic signals) is low. In the COMPUTER CONTROL program, the DUTY CYCLE signal is held high by the GDP-32 until a measurement is being made. In RPIP and TDIP, however, the DUTY CYCLE is always high or alternating at twice the frequency of the selected measurement frequency.
2. Execute the ZETA program. Select MODE/Mx-30 Checkout. In this mode, ZETA will communicate only with the MX-30. It will try to setup the GDP-32.
3. Select File/Load to load one of the CRES schedules, CRES_CR1 for the cable used for electrodes 1-15 or CRES_CR2 for the cable with electrodes 16-30.
4. Select Control/Start. When ZETA prompts you for a file name, click Cancel. This will cause ZETA to exit the running the schedule but will leave the MX-30 in the state corresponding to the first (and only) line in the schedule.
5. On the GDP-32, exit the Computer Control program and execute either TDIP or RPIP. **IMPORTANT**: Make sure that the ZT-30 is RESET so that it will not transmit when you get into TDIP or RPIP where the Transmitter I/O signals become active.
6. Continue through the panels making sure that you have 13 channels ON. When you get to the 4th screen (the one that prompts "Press CONTINUE to set gains"), press the CRES key. The GDP will then measure the contact resistances for each of 12 dipoles (as indicated in Table 1) on channels 2-13. Ignore the contact resistance indicated for channel 1 as that channel is normally hooked to the output of the Isolation amplifier.
7. To measure the contact resistance of the second cable, repeat steps 3, 4 and press CRES on the GDP-32.

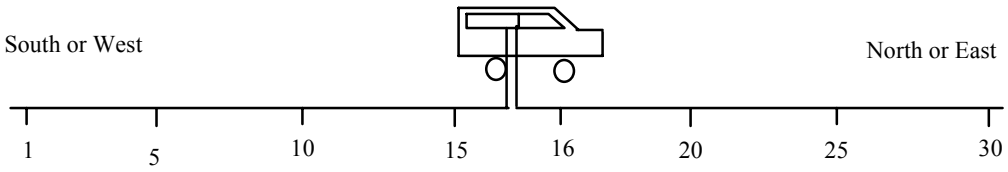
Use Table 1 to indicate which dipoles contain bad electrodes. Notice that the schedules I'm using test each of the cables in the same way if you go by the cable takeout number convention (i.e. number takeouts from 1-15, with takeout 1 being nearest the connector in use). Thus, channels 2-4 each measure a separate dipole with no common electrodes. Channels 5-13 all have takeout 6 as a common electrode. If you have a CRES problem on channels 2-4, you will have to examine 2 electrodes. However, provided channel 4 reads OK, contact resistance problems on channels 5-13 will be electrode specific (since electrode 6 is checked by channel 4 and then is common to the rest of the channels). The current electrodes are placed at the end of the electrode cable not under test. I did this so that if you forget to RESET the ZT-30 (Step 1) so that the transmitter electrodes are hot, there will be less chance that one of the crew inadvertently starts fooling around on the wrong cable and gets shocked.



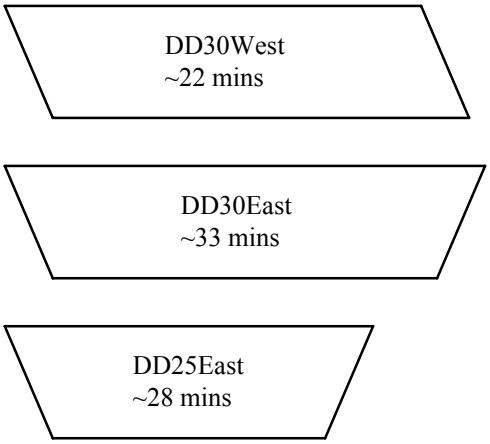
ZETA SYSTEM SETUP DIAGRAM

Zeta System

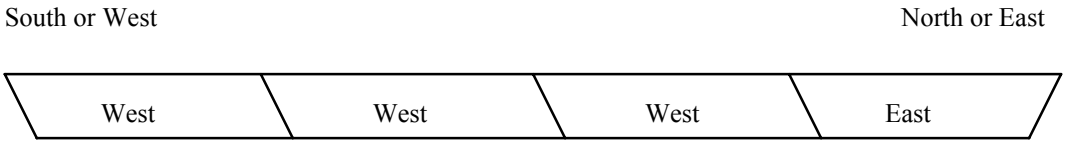
Set up lines with Electrode One on the south or west end of the line, and Electrode Thirty on the north or east. Number the spreads in each line with One at the south/west end and increase to the north/east.



Three schedules exist:



On a line, use DD30West schedule for all but the last spread. The last spread should either be a DD30East or DD25East, depending on the length of the line. If a spread of 25 electrodes will finish the entire line, use DD25East since it takes less time to run.



Cable Connections:

ZPB-600

24 VDC	==> 2 12 V batteries in series
Output	==> Main power on ZT-30

ZT-30

Main power	==> Output on ZPB-600
Battery charge	==> Nanotem battery
Isoamp	==> Ch. 1 on GDP 32
External input	==> Transmitter I/O on GDP-32
Red/Black transmitter plugs	==> MX-30 Transmitter input

GDP 32

Battery charge	==> Nanotem battery
Transmitter I/O	==> External input on ZT-30
Serial port	==> Laptop
Ch.1	==> Isoamp on ZT-30
Ch. 1-8	==> Ch. 1-8 on MX-30
Ch. 9-16	==> Ch. 9-16 on MX-30
Case ground	==> Ground pot

MX-30

Ch. 1-8	==> Ch. 1-8 on GDP 32
Ch. 9-16	==> Ch. 9-16 on GDP 32
Transmitter input	==> Red/black transmitter plugs on ZT-30
Serial input	==> PC-card in laptop
Power output	==> MX-30 battery (MX-30 top plug under "Serial Output" label)

Laptop

Serial port	==> Serial port on GDP 32	
PC-card	==> Serial input on MX-30	
Power source:	NanoTEM battery	= 3 hrs
	GDP battery	= 7 hrs
	Optima battery	= 2-3 days

Charge at night:

1. ZT-30
2. GDP-32
3. All batteries

Power-Up Sequence:

1. Laptop
2. GDP- press 8 for computer control.
3. MX-30
4. ZT-30 (2 switches; Input voltage ~250 - 350 mV; Damping = OFF
5. ZPB-600; push 400
   Regulation = Volt
   Mode = Direct

To run:

1. Transmit current.
2. Choose 'MX30 to GDP32' icon on desktop.
3. Click 'FindMX30' on menu bar. Only Box 1 should be found. (This step does not need to be repeated for each spread - only when the system is powered up for the first time).
4. Under 'File' choose the survey schedule.
5. Under 'Control' choose 'Start'.
6. Plant ground pot at least 15 feet (one dipole) from survey line.
7. Name the line. The convention is L#S# (L = line, S = spread)
8. A box will appear in which you can identify the operator and make comments about the spread if needed.

Notes:

- When the schedule for transmitter electrodes 15 and 17 is complete and the MX-30 is switching to the next transmitter setup, the wire with electrodes 1 through 15 is ready to be disconnected and pulled.

- Occasionally an "unknown command," or "GDP wait timeout" error may show up on the computer screen, or "channel saturated" may appear on the GDP. The schedule will terminate if the OK button is not pressed and CONTINUE on the GDP is pressed (if necessary) in less than a minute or so.

- Unusable data will most likely result if the current falls lower than 0.1 Amps.

- In very rocky areas, low current may prevent the acquisition of good data. Contact resistance can be reduced by clearing the surface of large rocks as best as possible, digging a shallow depression and shoveling in some dirt before putting the electrode down. Cover the electrode with more dirt and water generously. If this does not improve the data sufficiently, it may be necessary to double the size of the electrodes by connecting two with short pomona cables.

- If the ground pot is planted too close to the line (less than one dipole), the data will start to go bad around electrodes 13-17.

Checklist:

_____ GDP-32

_____ MX-30

_____ ZT-30

_____ ZPB-600

_____ Laptop w/ Serial PC-card

_____ 2 NanoTEM batteries

_____ 1 MX-30 battery

_____ 2 Deep-cycle 12V batteries (in series)

_____ Extensions

_____ Ground Pot

_____ 3 battery chargers

_____ 2 UC-2s

_____ Cables

_____ Electrodes

____ Short pomona cables

_____ Water

_____ Picks

Example of Good Data:

ControlMxGdp Version 1.15
Operator: JOSH
Comment:
Date and Time: 9/10/1999 14:53:42
Program: TDIP Frequency : 0.5 Number of Cycles: 8
Current Sense Resistance: 1.000
Measurement Schedule File Name: C:\Zeta\dd30s_west.sch
Notch Filters: Fund 3rd 5th 9th AntiAlias: Noisy

	Vp/I	M	V	M	I	M	SEM
0003 Tx 01 03							
Rx 06 04	6498.914	3.5	1495.4	3.5	230.1	0	0
Rx 07 05	1181.66	5.4	271.9	5.4	230.1	0	0.02
Rx 08 06	462.842	5.6	106.5	5.6	230.1	0	0.03
Rx 09 07	332.408	4.8	76.487	4.8	230.1	0	0.02
Rx 10 08	178.818	4.2	41.146	4.2	230.1	0	0.04
Rx 11 09	112.542	3.6	25.896	3.6	230.1	0	0.07
Rx 12 10	171.891	3.2	39.552	3.2	230.1	0	0.03
Rx 13 11	176.137	3	40.529	3	230.1	0	0.04
Rx 14 12	126.662	3	29.145	3	230.1	0	0.06
Rx 15 13	113.955	2.9	26.221	2.9	230.1	0	0.05
Rx 16 14	109.009	3.1	25.083	3.1	230.1	0	0.28
Rx 17 15	86.636	1.9	19.935	1.9	230.1	0	0.43
0004 Tx 02 04							
Rx 07 05	2748.16	5.2	672.2	5.2	244.6	0	0.01
Rx 08 06	645.135	6.5	157.8	6.5	244.6	0	0.01
Rx 09 07	385.155	5.6	94.209	5.6	244.6	0	0.03
Rx 10 08	198.348	5.3	48.516	5.3	244.6	0	0.06
Rx 11 09	117.118	5.3	28.647	5.3	244.6	0	0.06
Rx 12 10	180.254	3.4	44.09	3.4	244.6	0	0.03
Rx 13 11	180.082	3.5	44.048	3.5	244.6	0	0.06
Rx 14 12	123.688	4.3	30.254	4.3	244.6	0	0.06
Rx 15 13	111.885	3	27.367	3	244.6	0	0.07
Rx 16 14	107.882	1.4	26.388	1.4	244.6	0	0.36
Rx 17 15	84.133	2.4	20.579	2.4	244.6	0	0.13
Rx 18 16	64.814	4.4	15.86	4.4	244.7	0	0.17

Example of Bad Data:

ControlMxGdp Version 1.15
Operator: JOSH
Comment:
Date and Time: 9/10/1999 14:53:42
Program: TDIP Frequency : 0.5 Number of Cycles: 8
Current Sense Resistance: 1.000
Measurement Schedule File Name: C:\Zeta\dd30s_west.sch
Notch Filters: Fund 3rd 5th 9th AntiAlias: Noisy

	Vp/I	M	V	M	I	M	SEM
0006 Tx 15 17							
Rx 30 28	2477.74	9.1	662.3	9.1	267.3	0	1.65
Rx 20 18	15593.34	3.6	4168.1	3.6	267.3	0	0.26
Rx 21 19	3829.031	2.4	1023.5	2.4	267.3	0	0.03
Rx 22 20	1215.488	2.1	324.9	2.1	267.3	0	0.03
Rx 23 21	494.95	2.4	132.3	2.4	267.3	0	0.02
Rx 24 22	93.479	0.3	24.987	0.3	267.3	0	0.18
Rx 25 23	-217.74	5.6	-58.202	5.6	267.3	0	0.08
Rx 26 24	-1110.737	5.6	-296.9	5.6	267.3	0	0.07
Rx 27 25	-284.13	12.7	-75.948	12.7	267.3	0	2.96
Rx 28 26	-986.906	15.1	-263.8	15.1	267.3	0	6.79
Rx 29 27	748.597	7.2	200.1	7.2	267.3	0	0.23
0006 Tx 17 19							
Rx 30 28	-3628.571	4.1	-889	4.1	245	0	0.21
Rx 22 20	9486.939	1.5	2324.3	1.5	245	0	0.01
Rx 23 21	2566.531	1.6	628.8	1.6	245	0	0
Rx 24 22	720.816	1.4	176.6	1.4	245	0	0.07
Rx 25 23	-4.806	229.7	-1.177	229.7	245	0	229.76
Rx 26 24	-1242.449	10.8	-304.4	10.8	245	0	0.13
Rx 27 25	-3071.02	7.7	-752.4	7.7	245	0	0.84
Rx 28 26	5546.531	5.5	1358.9	5.5	245	0	0.07
Rx 29 27	3903.673	6.8	956.4	6.8	245	0	0.62

I. Version information.

A. General considerations

The **ZETA** system consists of a laptop computer, running the **ControlMxGdp** program, a MX-30 30-channel electrode multiplexer and a GDP-32 or GDP-32^{II}.

The **ControlMxGdp** program reads a list of MX-30 configurations from a schedule file. Each configuration consists of a pair of transmitter electrodes and up to 16 pairs of receiver electrodes. The program configures the MX-30 so that the transmitter electrodes are connected to a transmitter and the receiver electrodes are connected to GDP-32 receiver channels as specified. It then sends a sequence of commands to the GDP-32 which configure it and cause it to capture data on its active channels.

Some of the commands sent to the GDP-32 just configure it, but some result in transfer of data and/or data descriptors from the GDP-32 to the laptop computer. In the text below the term "block" is used to describe the information returned to the laptop computer in response to a command.

B. Versions predating ControlMxGdp Version 2.00

These versions run against the GDP-32 with LLL204x eproms in computer control mode or the **Zrt.exe** program in computer control mode.

C. Versions postdating Version 2.00.

These versions run against the GDP-32^{II} running in **Zrt**, computer control mode. The main difference in the data is that every data block is framed by STX-ETX (ascii 2 and ascii 3) and every data block contains a GDP32^{II} error code.

II. General format information.

A. Header block

An example header block is shown below.

```
ControlMxGdp Version 1.14
Operator: dbf
Comment: Steamtech eqt, braid electrodes sorted schedule with reciprocals.
Date and Time: 09/23/1999 15:08:36
Program: TDIP Frequency:   0.5 Number of Cycles: 8
Current Sense Resistance:    1.000
Measurement Schedule File Name: C:\ControlMX30Gdp32\V114\DD213012s.sch
Notch Filters: Fund 3rd 5th 9th AntiAlias: Std
```

The header block format is the same for pre- and post- version 2.00.

B. "WHO" block.

The block immediately following the header is received from the MX-30 in response to the "WHO" command. It describes the electrode configuration for the data to follow. An example is shown below.

```
Tx+,01
Tx-,03
Rx 01,Present,0
Rx 02,Present,0
Rx 03,Present,0
Rx 04,Present,02-
Rx 05,Present,03-
Rx 06,Present,02+,04-
Rx 07,Present,03+,05-
Rx 08,Present,04+,06-
Rx 09,Present,05+,07-
Rx 10,Present,06+,08-
Rx 11,Present,07+,09-
Rx 12,Present,08+,10-
Rx 13,Present,09+,11-
Rx 14,Present,10+,12-
Rx 15,Present,11+,13-
Rx 16,Present,12+
Rx 17,Present,13+
Rx 18,Present,0
Rx 19,Present,0
Rx 20,Present,0
Rx 21,Present,0
Rx 22,Present,0
Rx 23,Present,0
Rx 24,Present,0
Rx 25,Present,0
Rx 26,Present,0
Rx 27,Present,0
Rx 28,Present,0
Rx 29,Present,0
Rx 30,Present,0
Rx 31,Present,0
```

The first two lines relate which electrodes are used for the transmitter positive and negative poles, "TX+" and "TX-". Note that the numbers following those labels are the MX-30 electrode connections.

The remaining lines describe the receiver electrode configuration. The line

```
Rx 15,Present,11+,13-
```

relates the information that MX-30 connection 15 has a multiplexer board, "Present", and that it is connected to GDP-32 channel 11 positive and channel 13 negative poles.

Note that there is no MX-30 connection 31. The line

```
Rx 31,Present,0
```

indicates that this block was synthesized by the ControlMxGDP program, as a time saving measure, rather than transmitted from the MX-30.

C. "DATA" block

The next block contains the raw data from the GDP-32(II). For the TDIP survey type the first column is *primary voltage*, second is *chargeability* and the third is the *sp* in millivolts.

The format of this block differs between pre- and post-version 2.00 data. A pre-version 2.00 block is shown below and below it a post-2.00 block.

```
!DATA
 0.9024         0.0     -4.67
 1.5895         0.6    -47.37
 0.7209         0.7     26.21
 0.4296         0.7    -27.45
 0.2520         0.8     -8.78
 0.1482         0.8     59.61
 99.238e-3      0.6     90.72
 55.507e-3      0.6    100.74
 44.201e-3      0.9    -25.13
 32.096e-3      0.7    -46.26
 23.968e-3      0.7    -46.25
 19.243e-3      0.0     18.25
 13.070e-3      0.0    142.41
      0         0.0      0.00
      0         0.0      0.00
      0         0.0      0.00
```

The GDP-32II responds to every command by first echoing the command and every response is framed by STX-ETX so the "_DATA" is actually <STX>DATA<LF>. Because STX and ETX are non-printing characters, they may be represented by different characters in different word processors. For instance, in **Notepad** both appear as ' ' but in **Word** they appear as '_'.

The ",3,56" is an error code followed by the GDP-32II data cache file block number. The data cache was turned off for this data set, so the block number will not change. The data block is followed by ETX which appears as '_' at the beginning of the "V/I" block.

```
!DATA
_DATA
,3,56
 1.382          0.0     -2.88
 2.427          0.6     -8.93
 1.101          0.8    -22.11
 0.656          0.8     19.36
 0.386          0.8     74.02
 0.227          0.9     40.79
 0.152          0.9    -74.02
 0.085          0.6     21.84
 0.067          0.6     17.72
 0.049          0.9    -45.32
 0.036          0.8     18.26
 0.029          0.4     19.78
 0.020          0.3     30.21
     0          0.0      0.00
     0          0.0      0.00
     0          0.0      0.00
```

D. "V/I" block

This block is computed in the **ControlMXGdp** program and is the same for both pre- and post-V2.00 ZETA. They may appear to be slightly different because of the ETX mentioned above.

At the end of the "V/I" block is the sequence number. Post-v2.00 data has the cache block number following the sequence number and separated from it by a space. The sequence number begins at 1 in pre-v2.00 and 0 in post-v2.00 data.

```
V/I
5.519961e+003   6.000000e-001   -3.440000e+000 2.240000e+003   6.000000e-001   4.058000e+002   0.000000e+000
1.125924e+003   5.000000e-001   -1.930000e+000 4.569000e+002   5.000000e-001   4.058000e+002   0.000000e+000
3.166585e+002   3.000000e-001   2.080000e+001 1.285000e+002   3.000000e-001   4.058000e+002   0.000000e+000
1.138073e+002   4.000000e-001   5.920000e+000 4.618300e+001   4.000000e-001   4.058000e+002   0.000000e+000
6.104485e+001   6.000000e-001   6.750000e+000 2.477200e+001   6.000000e-001   4.058000e+002   0.000000e+000
4.157713e+001   6.000000e-001   2.437000e+001 1.687200e+001   6.000000e-001   4.058000e+002   0.000000e+000
4.233859e+001   3.000000e-001   1.005000e+001 1.718100e+001   3.000000e-001   4.058000e+002   0.000000e+000
3.264416e+001   0.000000e+000   -1.129000e+001 1.324700e+001   0.000000e+000   4.058000e+002   0.000000e+000
1.615476e+001   3.000000e-001   -2.340000e+000 6.555600e+000   3.000000e-001   4.058000e+002   0.000000e+000
1.223854e+001   4.000000e-001   7.980000e+000 4.966400e+000   4.000000e-001   4.058000e+002   0.000000e+000
8.054707e+000   4.000000e-001   1.930000e+000 3.268600e+000   4.000000e-001   4.058000e+002   0.000000e+000
8.333908e+000   2.000000e-001   -3.440000e+000 3.381900e+000   2.000000e-001   4.058000e+002   0.000000e+000
 1
```

E. "GSEM" block

This block is the *SEM* received from the GDP-32(^{II}). A pre-V2.00 version is shown below and below it a post-V2.00 version.

```
GSEM
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
   0.00
```

As is the case for the DATA command, the GSEM command is echoed. The line shown below as "_GSEM" is actually "<STX>GSEM<LF>" as discussed above. The next line ",0, 0.01" contains the GDP32II error code followed by the first SEM value.

```
GSEM
_GSEM
,0,   0.01
   0.01
   0.01
   0.01
   0.01
   0.02
   0.01
   0.02
   0.03
   0.02
   0.03
   0.04
   0.04
   0.00
   0.00
   0.00
```

F. "GTGN" block

This block gives the *gains* and *attenuations* for each channel. Below is a pre-V2.00 block followed by a post-V2.00.

```
GTGN
 1   2   1 0
 1   1   1 0
 1   2   1 0
 1   4   1 0
 1   8   1 0
 1  16   1 0
 1  16   1 0
 1  32   1 0
 1  32   2 0
 1  64   1 0
 1  64   1 0
 1  64   2 0
 1  64   2 0
 1   1   1 1
 1   1   1 1
 1   1   1 1
```

The '_' in the first line of the post-v2.00 block is actually the ETX framing character from the preceding GSEM block. The '_' in the next line is the STX framing the GDP-32[II] response. The ',0,' in the first line is the error code.

```
_GTGN
_GTGN
,0, 1   1   2 0
 1   1   1 0
 1   2   1 0
 1   4   1 0
 1   4   1 0
 1   8   1 0
 1  16   1 0
 1  16   2 0
 1  32   1 0
 1  32   1 0
 1  64   1 0
 1  64   1 0
 1  64   2 0
 1   1   1 1
 1   1   1 1
 1   1   1 1
```

G. "WNDO" block

The pre-V2.00 data were acquired with a GDP-32 having LLL204x eproms. The code in those eproms does not support the "WNDO" command. A post-V2.00 WNDO block is shown below. Each line has 13 values that are transient voltages averaged over a set of approximately logarithm windows.

```
_WNDO
_WNDO
,0,004219 000036 000005 000000 000000 000000 000000 000000 000000 000000 000000 000000 000000
004220 000021 000003 000000 000000 000000 000000 000000 000000 000000 000000 000000 000000
004202 000055 000010 000002 000001 000000 000000 000000 000000 000000 000000 000000 000000
004126 -000022 -000011 -000004 -000001 000000 000000 000000 -000001 000000 -000001 000000 000000
004276 000113 000036 000009 000003 000000 000000 000000 000000 000000 000000 000000 000000
003520 -000303 -000071 -000023 -000006 000000 000000 000001 000001 000001 000000 000001 000001
005679 000846 000226 000067 000021 000007 000005 000001 000000 -000003 -000001 -000002 000000
001176 -001547 -000425 -000138 -000056 -000021 -000016 -000008 -000009 -000009 -000007 -000008 -000003
010172 003268 000883 000296 000114 000061 000033 000030 000032 000036 000026 000022 000012
-009126 -007010 -001910 -000581 -000243 -000143 -000090 -000075 -000029 -000013 -000020 -000010 -000014
024622 010569 002900 000790 000249 -000068 -000165 -000055 -000134 -000227 -000192 -000229 -000160
-037301 -019905 -005496 -001695 -000642 -000424 -000306 -000358 -000037 -000109 -000100 -000064 000015
039852 015910 003415 000744 -000064 -000277 000060 -000078 -000232 -000211 -000768 -000512 -000522
0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0
```

H. Repeat blocks

If the **ControlMxGdp** program is configured to acquire more than 1 repeat block per transmitter pair, the DATA, GSEM, GTGN and possibly WNDO blocks are repeated until the repeat count is satisfied.