GPR Software Investigation

This is a report into the software and other files provided by Willtek to Jim Reerink, to answer the question "Can we do anything interesting with these programs?"

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Summary

The information provided is comprehensive and includes almost everything necessary to calibrate, test and validate the GPR receivers. This includes brief instructions for removing the UNCAL message.

Unfortunately, to actually use the programs a significant quantity of additional equipment is required, and it may not be possible to replicate exactly the original environment. I have managed to partially run some of the programs and obtain screenshots. These show that the resulting data is not actually very exciting and largely consists of tables of data.

However, it should still be possible to connect the GPR to a modern computer for remote control, and probably easier to write new programs that are interesting to look at! For more details see the Appendix.

File and Folder Structure

The ZIP Folder contains:

- **CAL.BAT** - correctly placed shortcut to the programs in the QB folder
- **MENU.EXE** - correctly? placed shortcut to the programs in the correction folder
- **Correction of Power meter configuration.**doc - MS Word document showing the equipment setup necessary for the use of programs in the correction folder
- **Report on the GPR Correction and Calibration Program.doc** - brief report on someone taking over these programs some time previously

- **LCD segment mod.doc** - Description of some minor hardware modification
- **TP*.doc** - Assorted Test Procedure documentation, mostly to do with hardware adjustments (potentionmeters, switches etc.) on the RF and IF modules of the GPR. Note however that **TP43_44xxA.doc** contains a note on how to remove the GPR "UNCAL" message (See next section).
- **TP*.DOC** - (Note Upper Case) Further test procedures as above, but cannot be opened by current versions of MS Word. The text can be recovered however using a text editor.
- **correction** - Folder
- **QB** - Folder

The correction folder contains:

- ***** - Various compiled BASIC programs and supporting data files, see separate section. Note that no source code is provided for these programs

The QB folder contains the following files. (Note that there is considerable duplication and redundancy in this folder).

- ***.COM *.BAS *.LIB** etc - Microsoft QuickBasic 4.5 run time and support files. **QB.EXE** is the primary executable file here
- **NOISE.BAS** - (probably misplaced) copy of same file from gpr folder
- **ADVR_EX** - Example QuickBASIC files provided by Microsoft (can be ignored)
- **gpr** - Folder, containing GPR testing and calibration programs and supporting files (see below)
- **GPR4200** - Folder, containing copies of program files only from the gpr folder (can probably be ignored, but may have minor differences for GPR 4200 variants?)

The QB/gpr folder contains the following files:

- ***.BAS** - A suite of programs to test and record results from the gpr (see detailed section below)
- **res** - Folder, containing around 500 plain text files containing results of various GPR test runs
- **SIGGEN** - Folder, containing 5 plain text files. These contain (I think) settings for the attenuator at various frequencies for different models of signal generator

GPR "UNCAL" Message

The document **TP43_44xxA.doc** contains the following information (page 6):

> **N.B**. If unit does not calibrate (uncal on display), it will be necessary to enter a calibrated correction at 150MHz.
>
> ....
>
> Tune signal generator to 150MHz, 100dBµV, set R&S attenuator to 60. Enter special functions in GPR, turn turning wheel to calibrate. correction, press soft button key. Then press cal. button until 150MHz is displayed. Press soft button. After cal operation has been completed, hold down soft button for 1 second, and then hold down soft button for a further 1 second.

If I recall correctly, you “enter special functions” by pressing all four buttons simultaneously and spinning the wheel anti-clockwise…?

The recommended Signal Generator is an Adret 740A (0.1MHz to 1120MHz)

The attenuator is a Rhode & Schwarz unit, model unkown

Comments

If a signal generator is not available it strikes me that *any* signal present (e.g. an antenna), if the procedure above is followe, should make the "UNCAL" message go away - the input signal is just used as a reference level, so giving it the "wrong" level should just cause it to "calibrate" with wrong readings when showing signal levels.

Running the programs in the GPR Folder

These programs are written in Microsoft QuickBASIC 4.5. To run, ensure that you are in the folder:

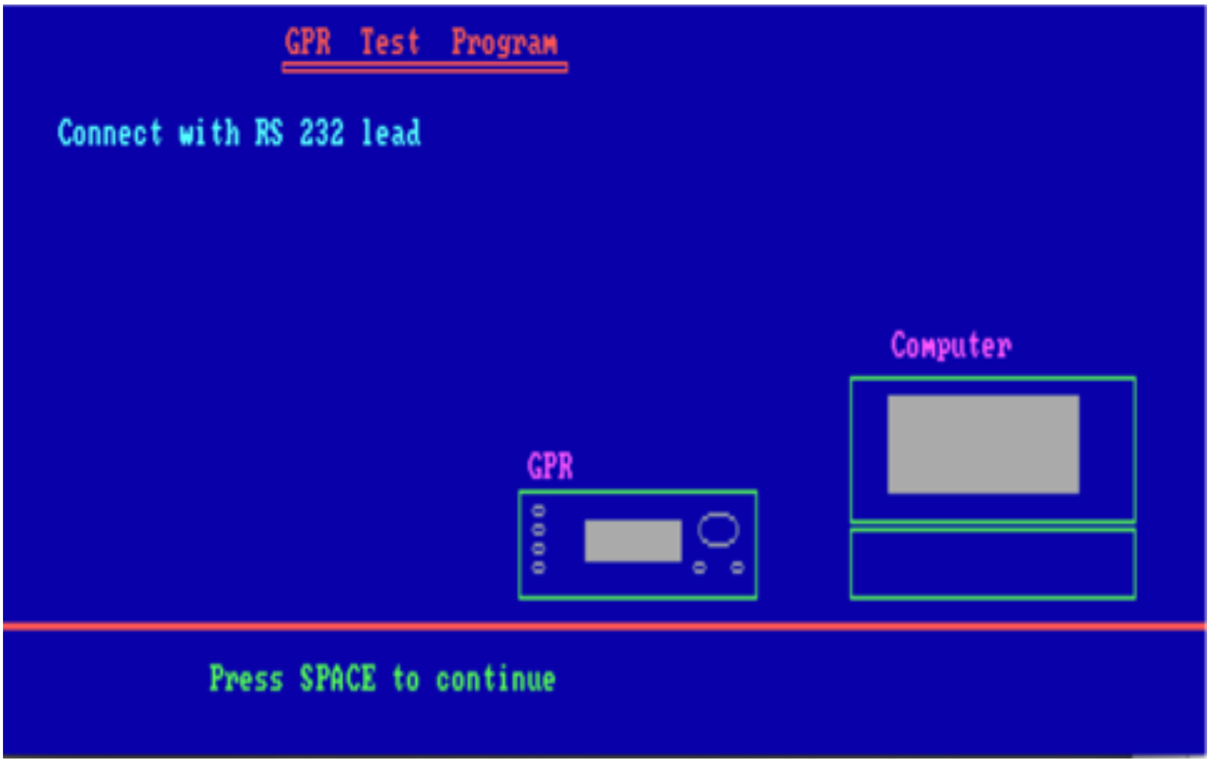
QB

and run the following command:

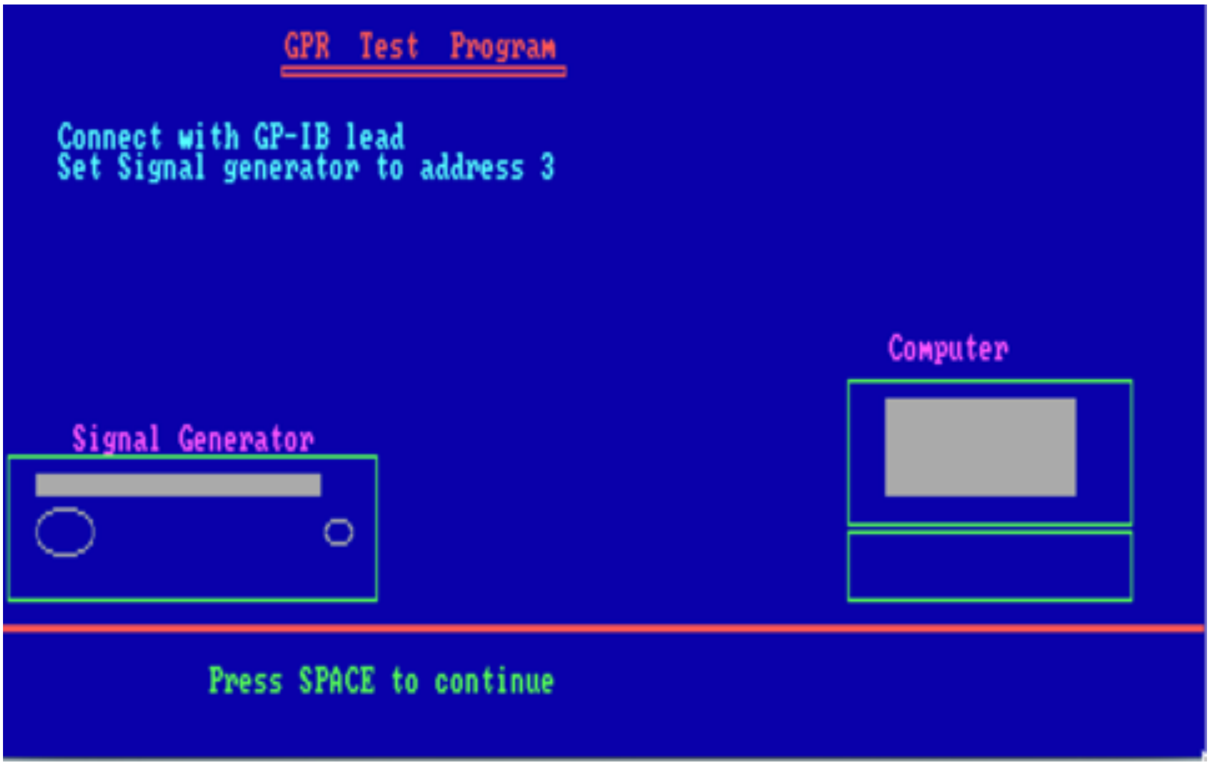
```
qb /ah /l c:\qb\basic /RUN c:\qb\gpr\conn0
```

(For the purposes of testing, the program was run under DOSBox 0.74 on OS X 10.11.1)

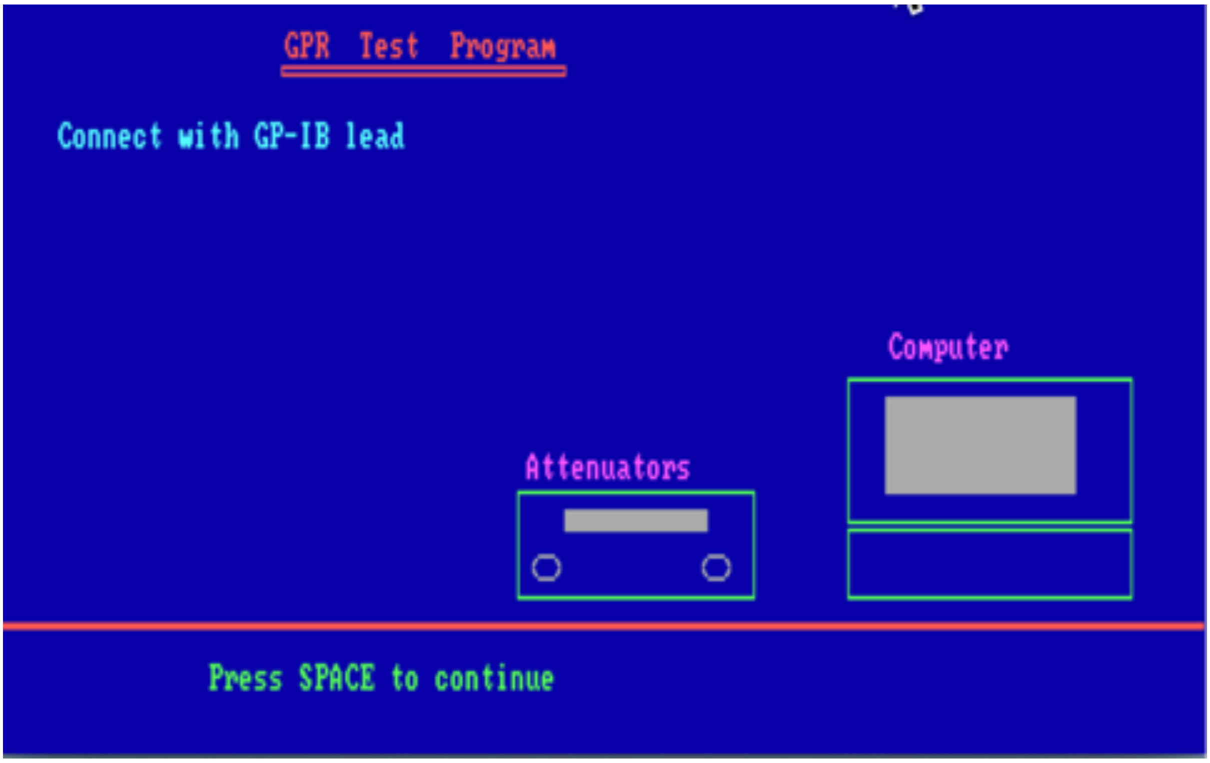
The following screens appear: (keys pressed are shown after each screen)



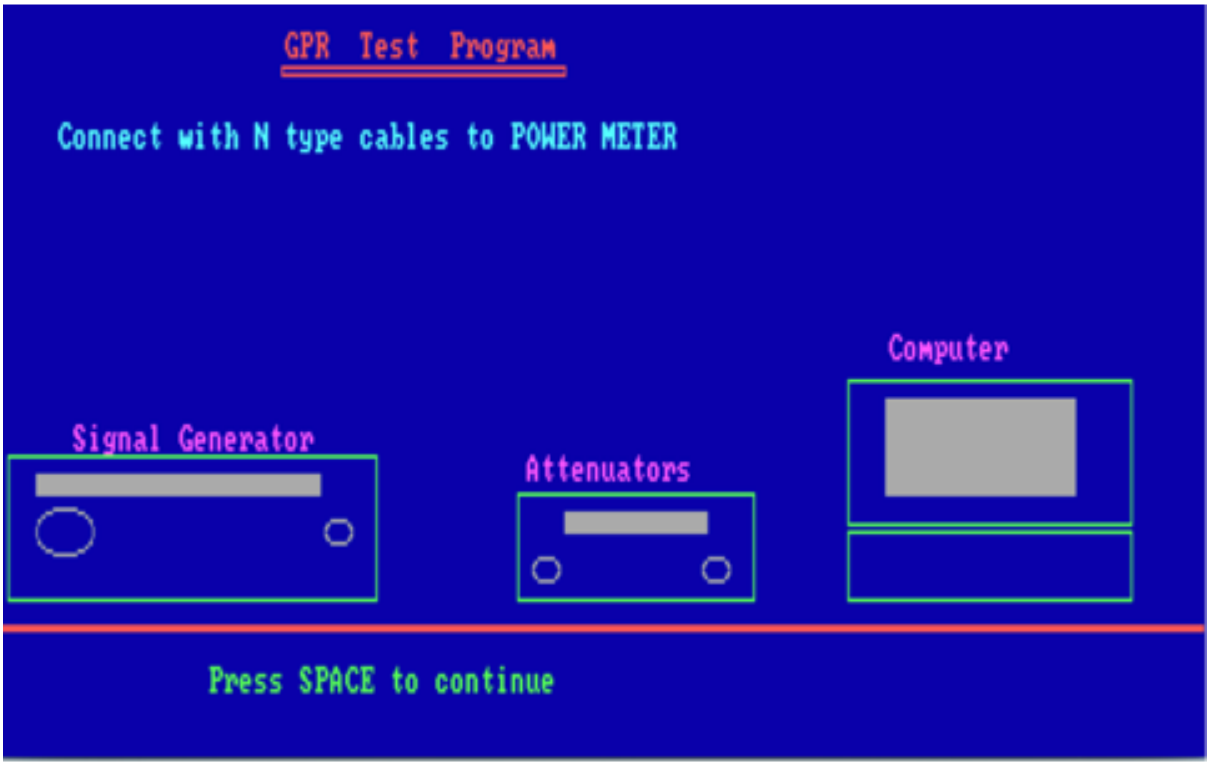
<space>


GPR Test Program
Connect with GP-IB lead
Set Signal generator to address 3
Computer
Signal Generator
Press SPACE to continue

<space>

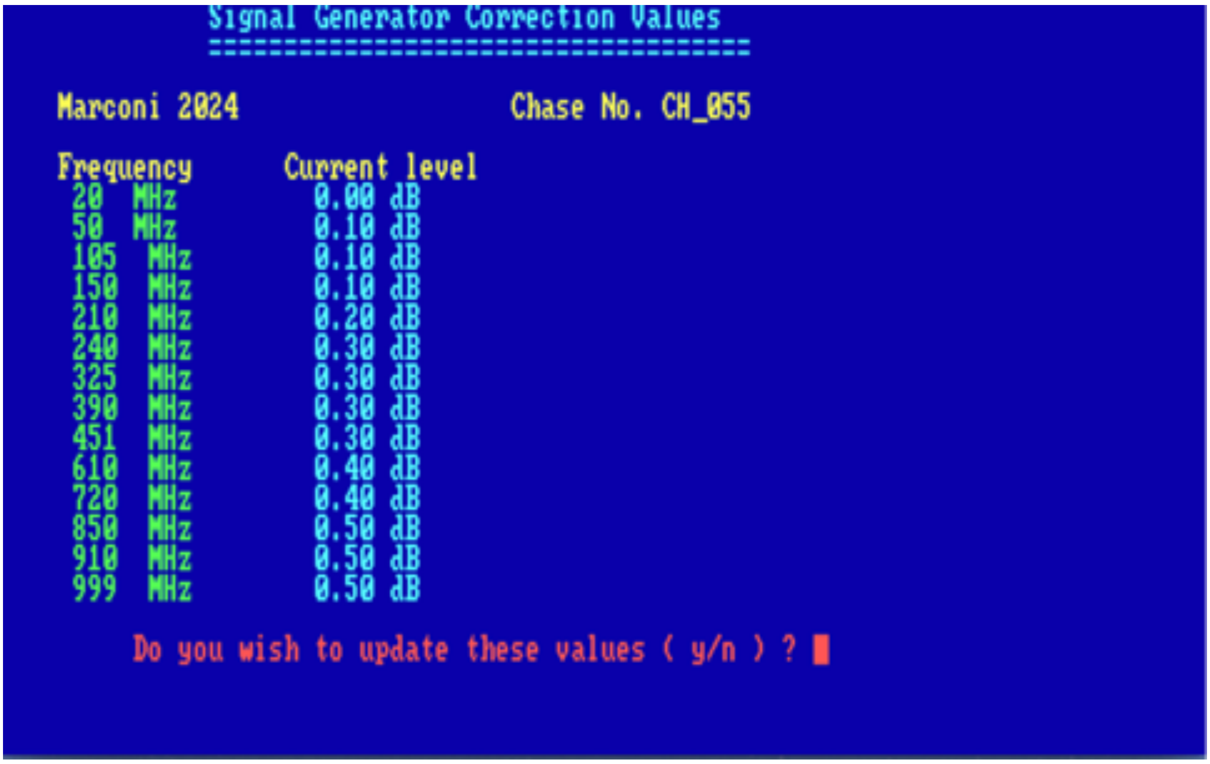

GPR Test Program
Connect with GP-IB lead
Computer
Attenuators
Press SPACE to continue

<space>



<space>

(The program then interrogates the signal generator to find out what model it is, and if it is a Marconi 2024, 2042 or 2031 displays the following:)



y

(This just allows manual entry of these values, and writes them to a file. So go back to previous screen and type 'n' instead gets to:

Each of these options runs a test procedure. They all follow a fairly similar pattern, taking as an example "F1 Input Level Accuracy", the follow actions take place: (determined from reading the code as I cannot run the program any further)

1) Open RS232 link to the GPR (9600 baud, 8 bit no parity), set bandwidth to 7.5KHz, Level Display readout and attenuation off

2) Open the link to the signal generator (either one of the Marconi's, or an Adret) and send some initialisation commands. (I'm not familiar with these)

3) Loop through each of the following values: 20,50,105,150,210,240,325,390,451,610,720,910,999

3a) Set the signal generator to that value in MHz at 20 dbm

3b) Read the signal level and receiver status from the GPR

3c) Set the signal generator to 80 dbm

3d) Read the signal level and receiver status from the GPR

4) Print out results

All test results are displayed on the screen and stored in a file (over 500 sets of test results are included). An example set of IP Level data is:

```
Level Accuracy
20            18.8          78.8
50            19.7          79.8
105           19.8          79.9
150           20.4          80.5
210           20.1          80.4
240           ----          ----
325           ----          ----
390           ----          ----
451           20.9          81.1
610           20.2          80.6
720           20.1          80.3
910           20.3          80.3
999           20.5          81.0
la end
```

(The dashes indicate frequencies that this particular model of GPR could not tune to - this was not a limitation of the hardware but a software feature to skip the old 625-line PAL format TV signal channels)

Comments

All the other tests are very similar to the above, both in the way that they work and the data displayed. Also note that some of them would take several hours to run.

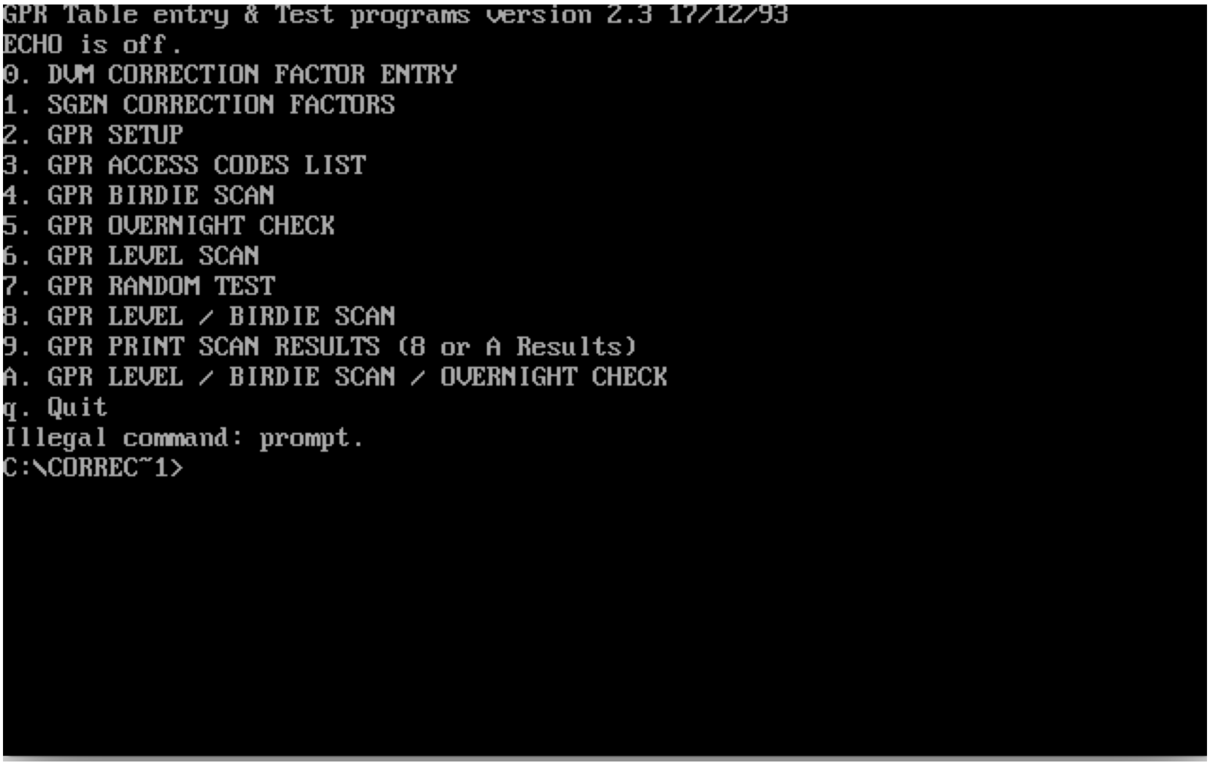
The programs are intended to validate the correct operation, and very high level of accuracy of the GPR receiver. They require some potentially expensive and hard to find hardware, including:

1. An old Windows 3.1 PC (should not be too difficult, but ideally it would have a 15-pin serial port, USB versions are available for more modern PCs b)
2. A GPIB interface card for the above (PCI bus versions are about $100 on E-Bay but may not necessarily have compatible driver software. Based on the age of the programs the card originally used probably had an AT bus interface. There are modern USB versions available, but again driver compatibility is likely to be an issue)
3. Cables for the above (easily sourced from e-bay / Amazon)

4. A signal generator (I located a working Adret 740A on e-bay US for $2,000!)
5. A digital volt meter
6. An attenuator (model unknown)

Once we have all of this we can calibrate and test the GPRs, but the resulting screen displays and printouts are not actually very interesting I'm afraid.

Running the programs in the Correction folder


```
GPR Table entry & Test programs version 2.3 17/12/93
ECHO is off.
0. DVM CORRECTION FACTOR ENTRY
1. SGEN CORRECTION FACTORS
2. GPR SETUP
3. GPR ACCESS CODES LIST
4. GPR BIRDIE SCAN
5. GPR OVERNIGHT CHECK
6. GPR LEVEL SCAN
7. GPR RANDOM TEST
8. GPR LEVEL / BIRDIE SCAN
9. GPR PRINT SCAN RESULTS (8 or A Results)
A. GPR LEVEL / BIRDIE SCAN / OVERNIGHT CHECK
q. Quit
Illegal command: prompt.
C:\CORREC~1>
```

These programs are written in BBCBasic, with a simple MSDOS "batch" file menu system. I'm not very familiar with BBCBasic and can't seem to view the source code of these programs. This might be my lack of understanding or the source code may be "hidden" (there is a BBCBasic command called UNLIST which does this.

(The item "Illegal command: prompt: line in the screenshot above is because this is an MS Windows command line feature and was not in the original MSDOS - DOSBox is an MSDOS emulator so it does not have this feature).

These programs will work the same way as those in the QB folder, sending commands to the GPR over an RS232 link and to a signal generator over a GPIB (IEEE-488) link.

The folder does contain some results files, for example the file "BIRDIES" (shown below) shows internally generated false signals for a specific reciever (usually the reciever picking up noise and harmonics from its own internal oscillators).

```
Frequency 293750 Hz  Level -8.8 dBuV
Frequency 312500 Hz  Level -8.1 dBuV
Frequency 318750 Hz  Level -6.7 dBuV
Frequency 325000 Hz  Level -7.7 dBuV
Frequency 331250 Hz  Level -7.9 dBuV
Frequency 337500 Hz  Level -7.8 dBuV
```

```
Frequency 343750 Hz  Level -8.3 dBuV
Frequency 350000 Hz  Level -6.9 dBuV
Frequency 356250 Hz  Level -8.0 dBuV
Frequency 362500 Hz  Level -8.4 dBuV
Frequency 375000 Hz  Level -9.9 dBuV
Frequency 387500 Hz  Level -8.8 dBuV
Frequency 406250 Hz  Level -8.3 dBuV
Frequency 412500 Hz  Level -8.7 dBuV
Frequency 443750 Hz  Level -9.1 dBuV
Frequency 475000 Hz  Level -9.8 dBuV
Frequency 481250 Hz  Level -7.8 dBuV
Frequency 493750 Hz  Level -9.4 dBuV
Frequency 500000 Hz  Level -7.9 dBuV
Frequency 543750 Hz  Level -9.9 dBuV
Frequency 575000 Hz  Level -9.8 dBuV
Frequency 587500 Hz  Level -9.5 dBuV
Frequency 625000 Hz  Level -9.2 dBuV
Frequency 675000 Hz  Level -9.0 dBuV
Frequency 687500 Hz  Level -9.2 dBuV
Frequency 700000 Hz  Level -9.6 dBuV
Frequency 19506250 Hz  Level -9.9 dBuV
Frequency 487225000 Hz  Level 2.9 dBuV
Frequency 511275000 Hz  Level -8.7 dBuV
Frequency 538125000 Hz  Level -4.2 dBuV
Frequency 543225000 Hz  Level 1.7 dBuV
Frequency 567250000 Hz  Level 5.4 dBuV
Frequency 574875000 Hz  Level -4.1 dBuV
Frequency 576750000 Hz  Level -4.9 dBuV
Frequency 586462500 Hz  Level -9.9 dBuV
Frequency 599275000 Hz  Level -4.4 dBuV
Frequency 616500000 Hz  Level -7.6 dBuV
Frequency 955100000 Hz  Level -6.1 dBuV
Frequency 955112500 Hz  Level -4.9 dBuV
Frequency 955118750 Hz  Level -3.3 dBuV
Frequency 955125000 Hz  Level -3.9 dBuV
Frequency 955131250 Hz  Level -0.2 dBuV
Frequency 955137500 Hz  Level -1.1 dBuV
Frequency 955143750 Hz  Level -0.1 dBuV
Frequency 955150000 Hz  Level 0.9 dBuV
Frequency 955156250 Hz  Level -3.0 dBuV
Frequency 955162500 Hz  Level 0.1 dBuV
Frequency 955168750 Hz  Level 3.6 dBuV
Frequency 955175000 Hz  Level -0.8 dBuV
Frequency 955181250 Hz  Level 0.7 dBuV
```

The file "SGENCFS" contains 113 readings (shown below) which I assume are the output of the SGEN Correction factors test (113 * 10MHz is the frequency range of the GPR), presumably the signal is expected to be 20dBm.

20.11	20.58	20.65	20.80	20.82
20.23	20.60	20.65	20.80	20.96
20.36	20.65	20.67	20.91	21.07
20.40	20.65	20.65	20.82	21.15
20.41	20.64	20.83	20.98	20.87
20.39	20.72	20.66	20.87	20.98
20.59	20.72	20.67	20.75	21.04
20.58	20.71	20.70	21.07	21.14
20.51	20.62	20.69	20.98	21.22
20.45	20.60	20.75	20.90	21.11
20.37	20.59	20.58	20.81	21.13
20.50	20.54	20.69	20.79	21.20
20.41	20.51	20.79	20.83	21.27
20.28	20.50	20.86	20.84	21.27
20.17	20.49	20.99	20.86	21.37
20.22	20.46	20.79	20.88	21.32
20.34	20.45	20.83	20.86	21.26
20.37	20.62	20.84	20.81	21.19
20.37	20.67	20.84	20.82	21.08
20.43	20.66	20.70	20.84	21.19
20.50	20.65	20.81	20.90	21.19
20.55	20.65	20.84	20.99	
20.57	20.64	20.82	20.68	

Comments

The same applies as the other programs, a similar set of equipment is required, and a similar rather dull set of displays results!

Conclusions

We originally asked the question "can we doing anything interesting with these programs?"

The short answer is, "yes, but probably not worth the effort".

The equipment necessary may be hard to find or quite expensive, and it may be hard to duplicate precisely the original hardware environment. Even if all is correct there are no "graphical" programs that can be run, they are all rather bland text based programs that result (at best) in a table of figures!

The exercise was useful however as we now know almost everything there is to know about the GPR receivers. We have almost complete circuit diagrams, the mechanical drawings, user manuals, calibration tools and marketing material.

What might be more interesting to do is connect the GPR RS232 to a modern PC and control it remotely, possibly reproducing some of the original programs that would display channel occupancy, signal levels over time and so on. This should not be difficult, USB to RS232 adapters are cheap and readily available, and should provide a programming interface to any modern programming language. It should also be noted that the Raspberry PI has a built-in RS232 interface so a dedicated computer for GPR can be constructed for very low cost.

Appendix 1 - GPR Remote Control

Given a simple USB to RS232 adapter (around $20 from Amazon) and a simple terminal program (e.g. for Windows, Hyperterminal, Termite etc.) it should be easily possible to send manually send commands to the GPR, and to see the replies. A summary of the command set is shown below:

COMMAND SYNTAX	COMMAND FUNCTION
AC [“Y”:”N”]	Auto Calibration
AD [“A”:”M”]	Audio Detect
AF [“Y”:”N”]	Audio Filter
AT [“Y”: “N” : “F”]	Attenuation
AT [“Y”:”N”:”F”:”1”-”5”]	Attenuation
BR [“A” -”O”]	Baud Rate
BW [“1”:”2”:”3”:”4”]	Bandwidth*
CL	Calibrate
CO [“Y”:”N”]	Channel Offset
DT {real}	Dwell Time
FR {integer:”+”:”-”}	Frequency
HS	Handshake
LD [“1”:”2”:”3”:”4”	Level Detect
LOC	Local Mode
LU [“1”:”2”:”3”:”4”]	Level Units
MC	Memory Clear
MD [num]	Memory Delete
MR [num]	Memory Recall
MS [num]	Memory Save
RD [“L”:”M”]	Readout
REM	Remote Mode
RS	Report Status
RV [“Y”:”N”:real]	Relative Value
SC [“+”:”-”]	Scan
SG	Signal Level
SM {“1”-”40”}	Step Memory
SQ {real}	Squelch Level
ST {see under ST command}	Status
TS [“1”-“7”]	Tuning Steps
TS [“1”-”9”]	Tuning Steps
VA [“Y”:”N”]	Variable Average
VN	Version Number
VT {integer}	Variable Average Time

* Bandwidths “4” is applicable to certain receivers only (refer to paragraph 6.4.5).

The full details of each command are to be found in the document ChaseReceiverReferenceManual.pdf

I think that the default serial data rate is 9600 baud, 8 bits no parity, but this is easily set in the GPR menu. The first command that should be sent is REM to put the receiver into remote control mode. When complete the sending LOC will return it to control via the normal controls.