

Limitations and Parallel-Port Interface Documentation of the Hung-Chang DSO-2100 PC-Based Oscilloscope

A while ago I needed to do some automated data acquisition and happened to be in possession of the DSO-2100 PC-based digital storage oscilloscope made by Hung Chang (Seoul, Korea) and sold under brand names like Protek or Voltcraft. Unfortunately, Hung Chang went bankrupt in 2001, and driver software that could be linked to user programs, though advertised in the instrument brochure, had never been made available. At least that's what I was told. I therefore had to analyze the Visual-Basic program that comes with the instrument.

Along the way I found that the DSO 2100 differs in important respects from the specifications stated in the instrument brochure and (until 2004) on the [Hung-Chang website](#), and also (until 2005) by [Conrad Electronic](#), a German electronics chain store where the instrument was on sale. Thus, you cannot acquire data from both inputs simultaneously, and only 5000 data points per trigger event are made available for uploading to the host! I felt quite annoyed when I realized this.

I also learned that, prior to the bankruptcy, a new Korean company called [MITech, Inc.](#) had taken over the Test & Measurement Department of Hung Chang, but their engineers preferred not to answer my technical questions. Since 2005, Hung Chang continues as [GSI Co., Inc.](#) in Incheon, Korea, and the DSO 2100 (or Protek 2100) still receives support on the website of their chinese subsidiary, [HCQ Electronics Co., Ltd.](#) in Qingdao.

I am herewith placing the results of my analysis on the Web. A simple test driver written in Turbo Pascal that implements DSO-2100 control via the parallel port can be obtained from the author and may serve as a starting point for programs of your own. Please direct requests, as well as comments and notifications of mistakes to [Clicliclic](#).

A friendly correspondent, Anton Zechner, from Austria has contributed an [upgrade utility](#) to make your DSO2100.EXE run under Windows NT or 2K or XP. Be sure to have a German dictionary around. And don't ask me for support on this!

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0. Remarks on DSO-2100 Limitations

- the DSO 2100 must be operated on a bi-directional parallel port (with the host BIOS configured accordingly!): only the eight data lines (pins 2-9) and the STROBE (pin 1), AUTO-FEED (pin 14), INIT (pin 16), and SELECT-IN (pin 17) control lines are wired. Old unidirectional ports won't do!

- electromagnetic interference, such as electromagnetic pulses generated by switching on the room lighting, may cause the communication between PC and DSO to hang up. Briefly unplug the power supply of the DSO unit to recover from this.

- in contrast to what the accompanying brochure suggests ("*Ch A: 100 MSa/s, Ch B: 100 MSa/s, Dual: 100 MSa/s*"), the DSO unit has only one digitization channel which is switched between the two analog input channels: capture of both inputs requires two successive trigger events even for single-shot acquisition, resulting in non-corresponding signals!

- data reloaded from previously stored *.dso files are vertically expanded relative to the measured

signal as originally displayed. On the other hand, data displayed during Scroll Mode measurements are vertically contracted relative to signals measured otherwise. In either case, the effect is dependent on the vertical offset setting!

- for each data acquisition completed, the on-board intelligence (an ADSP-2105 processor with 8 kB OTP EPROM and a QL2003 FPGA) makes only 5000 samples available to the host, although the digitization channel is equipped with 32+32 kB RAM. This falls far short of a memory depth of 32 kB/Ch, as also stated in the instrument brochure!

- even though the DSO unit prepares only 5000 samples for uploading, their acquisition takes twice as long as needed for 5000 consecutive data points. Consequently, the maximum repetition rate of the DSO 2100 at low scan speeds is only half of what one would expect. The inefficiency should be attributed to a bug in the DSO firmware.

- the Fourier transform for the spectrum display is based on $2^8 = 256$ samples (and thus generates only $2^7 + 1 = 129$ data points in frequency), and there are no data windowing options. Most unbelievably, of the 129 spectral points only 125 are actually displayed, the 21st, 64th, and 107th are skipped and the 128th is omitted! (Here, the spectral points are numbered from zero.) You can easily uncover the frequency holes by means of a tunable oscillator.

- digital data from the DSO unit always include 6 or 7 data points preceding the trigger event - a pleasant surprise for a change! The trigger, however, is accepted only before every other sample, causing a time jitter of two sampling intervals!

- at slew rates of about 3Div / 10ns, the ADC (actually two alternating HI5714s) begins to show glitches: the lower five bits gradually fail (folding section of the converter) while the upper three bits continue to function (subranging section of the converter). The sparkle is easily seen when a suitable signal is heavily "undersampled", but remains invisible in ordinary work. The behavior is in agreement with the "analog input bandwidth" specification of the HI5714 (provided the Harris/Intersil datasheet is read correctly - signal attenuation is comparatively unimportant here!).

- even for shorted inputs, at acquisition rates above 5 MSa/s (especially at 50 and 100 MSa/s) the data from my unit show a digital contamination of up to 0.3 Div p-p that may at first sight be taken for analog noise. The contamination is influenced by the various amplifier and trigger settings; obvious features are stronger isolated spikes (occasionally up to 0.6 Div) followed by a train of weaker equidistant (640 ns) peaks, this is sometimes (at 50 MSa/s) accompanied by a constant signal at half the sampling frequency.

- for open inputs there is a significant capacitive coupling from the EXT trigger signal onto CH2 at 0.5 V/Div and 50 mV/Div, suggesting bad routing on the PCB.

- the DSO amplifiers stop drifting and recalibration becomes unnecessary only after roughly one hour of warming-up and thermal equilibration!

- positive-slope triggering on fast signals (such as the 1 kHz calibration signal measured with a 10÷1 probe) is unreliable (frequent false release on negative slopes), in striking contrast with negative-slope triggering: for rapid transitions the trigger comparator (LM361) seems to suffer from some kind of ringing. For slow signals like a 50 Hz sine wave, the distinction of slopes seems to be lost as well, and triggering to be bistable without exception.

- the on-board analog calibration settings (stored in 1 µF capacitors gated by an HC4051) are not refreshed during acquisition, whence calibration drift results in a progressive (and ultimately prohibitive) signal distortion for measurements from 50 ms/Div (10 kSa/s) to 0.5 s/Div (1 kSa/s), i.e. with acquisition times exceeding 0.5 s.

- the auto-calibration procedure quite frequently fails to terminate within reasonable time; you may have to break and restart the process repeatedly.

- and finally, for daring fellow owners, I have prepared a [description](#) of what can be done about some of the hardware problems (mainly trigger instability and calibration drift) of the DSO 2100.

1. Control Sequences Employed by DSO2100.EXE

NORM-trigger acquisition without signal:

```
S04R0f..{R01} S02{R00}{R21} {S99{R21}}
```

NORM-trigger acquisition with signal:

```
S04R0f..{R01} S02{R00}{R21} {S99{R21}} S99{R00}{R03} {L}
```

AUTO-trigger acquisition:

```
S04R0f..{R01} S02{R00}{R21} S99{R00}{R03} {L}
S04R0f..{R01} S02{R00}{R21} S99{R21} S99{R00}{R03} {L}
S04R0f..{R01} S02{R00}{R21} S99{R21} S99{R21} S99{R00}{R03} {L}
S04R0f..{R01} S02{R00}{R21} S99{R21} S99{R21} S99{R21} Sfe{R21} S99{R00}{R03} {L}
and so on repeating {S99.. S99.. S99.. Sfe.. S99..}
```

acquisition break:

```
.. {R21} Sff{R00}{R03} {L}
```

reselect readout:

```
S04R0f..{R01} S03{R00}{R03} {L}
```

scroll acquisition:

```
S04R0f..{R01} S04 {{R14}{L}}
```

scroll-acquisition break:

```
.. {L} Sff{R0f}..{R01} ..
```

Notes:

- Rxx, Sxx, and L stand for Receive Status Byte, Send Command Byte, and Load Data Byte, respectively, where xx represents the transferred byte in hex; {} indicates repetition. The corresponding parallel-port operations are detailed in sections 3.C, 3.D, and 3.E, respectively.
- S02 starts a 5000-sample acquisition with selection of 500+500 readout points; S03 starts a reselection of 500+500 readout points from the previous data; S04 starts a scroll acquisition / a new setup-parameter transfer; S99 leaves acquisition if complete; Sfe supplies AUTO trigger; Sff breaks acquisition.
- R00 indicates On-board Processor Busy / Illegal Command; R03 indicates Acquisition Complete / Data Ready; R14 indicates Scroll Acquisition Active (scroll acquisition timing is determined by the host data requests!); R21 indicates Waiting for Trigger / Acquiring.
- the sequence R0f..R01 transfers setup parameters to the DSO; it is explicated in section 2.
- the LED indicator on top of the DSO unit lights up for any status but hex 03 (Acquisition Complete / Data Ready) after an acquisition; it stays on after a reselection.
- to my knowledge, the commands listed here exhaust those accepted by the DSO unit.

2. DSO-2100 Setup-Parameter Transfer

```
R0f ready for transfer
```

```
S01  select Acq CH1 (01,02 = CH1,CH2)
R0f
S01  repeat
R05
S02  set 50 MSa/s (01,02,03,04,05 .. = 100,50,25,20,10 .. MSa/s)
R05
S02  repeat
R08
S02  readout2 step + 1 (02,03 ...,0b)
R08
S02  repeat
R09
S0b  readout1 step + 1 (02,03 ...,0b)
R09
S0b  repeat
R06
S3b  set CH1 AC, 5 V/Div, Trig CH1
      (00,04,08 = DC,GND,AC)
      (01,02,20,21,22,30,31,32,33 = 10m,20m,50m,0.1,0.2,0.5,1,2,5 V/Div)
      (00,40,80 = Trig CH1,EXT,CH2)
R06
S3b  repeat
R07
S3b  set CH2 AC, 5 V/Div, Trig AC
      (00,40,80 = Trig AC,TV-V,TV-H)
R07
S3b  repeat
R0a
S01  readout2 shift (01,02,03,04,05 .. = 0,5,10,15,20 ..)
R0a
S01  repeat
R0b
S02  set Trig Slope pos (01,02 = neg,pos)
R0b
S02  repeat
R0c
S66  Cal CH1 V-Offset + 1
R0c
S66  repeat
R0d
S5d  Cal CH2 V-Offset + 1
R0d
S5d  repeat
R0e
S80  Trig Level + 1
R0e
S80  repeat
R10
Saa  Cal CH1 Offset + 1
R10
Saa  repeat
R11
S7c  Cal CH1 Gain + 1
R11
S7c  repeat
R12
S89  Cal CH2 Offset + 1
R12
S89  repeat
R13
Sba  Cal CH2 Gain + 1
R13
Sba  repeat
R01  transfer done
```

Notes:

- the purpose of the readout1 step, readout2 step, and readout2 shift parameters is explained in section 3.E.
- hex 03 and hex 23 are alternative codes for the 50 mV/Div and 0.5 V/Div settings; their advantage is a reduced noise level. Change DSO2100.EXE at hex file offset 29782 from hex 20 to hex 03 and at hex file offset 297c6 from hex 10 to hex 03 to see this.
- DSO2100.EXE seems to keep the trigger level fixed at 50% (hex 7f); the PCB is apparently not equipped for a variable trigger level!
- the V-Offset, Offset, and Gain calibration constants are stored in the file DSO2100.INI.
- the new parameter settings become effective only with the subsequent command (S02, S03, or S04).

3. DSO-2100 Parallel-Port Code from VKVXD.VXD

A. Initialize DSO port:

```

LEA  ESI, DWORD PTR [EBP+08]      ; port
MOV  EDX, DWORD PTR [ESI]
ADD  EDX, 00000402                ; (+ 402 !)
MOV  EAX, 00000020
OUT  DX, AL                       ; set ECP hardware to emulate a BPP

```

B. Verify DSO connection:

```

LEA  ESI, DWORD PTR [EBP+08]      ; port
MOV  EDX, DWORD PTR [ESI]
ADD  EDX, 00000002
MOV  EAX, 00000020
OUT  DX, AL                       ; STROBE+ AUTO+ INIT- SLCTIN+
OUT  DX, AL                       ;
OUT  DX, AL                       ;
OUT  DX, AL                       ;
OUT  DX, AL                       ;
OUT  DX, AL                       ;
MOV  EAX, 00000021
OUT  DX, AL                       ; STROBE- AUTO+ INIT- SLCTIN+
LEA  ESI, DWORD PTR [EBP+08]
MOV  EDX, DWORD PTR [ESI]
IN   AL, DX                       ; read status byte
AND  EAX, 000000FF
LEA  ESI, DWORD PTR [EBP+0C]
MOV  ESI, DWORD PTR [ESI]
MOV  DWORD PTR [ESI], EAX
ADD  EDX, 00000002
MOV  EAX, 00000020
OUT  DX, AL                       ; STROBE+ AUTO+ INIT- SLCTIN+

```

Note:

- a status of hex 55 is returned if the DSO is present.

C. Receive DSO status:

```

LEA  ESI, DWORD PTR [EBP+08]      ; port
MOV  EDX, DWORD PTR [ESI]
ADD  EDX, 00000002
MOV  EAX, 00000022
OUT  DX, AL                       ; STROBE+ AUTO- INIT- SLCTIN+

```

```

OUT    DX, AL                                ;
MOV    EAX, 00000023
OUT    DX, AL                                ; STROBE- AUTO- INIT- SLCTIN+
OUT    DX, AL                                ;
LEA    ESI, DWORD PTR [EBP+08]
MOV    EDX, DWORD PTR [ESI]
IN     AL, DX                                ; read status byte
AND    EAX, 000000FF
LEA    ESI, DWORD PTR [EBP+0C]
MOV    ESI, DWORD PTR [ESI]
MOV    DWORD PTR [ESI], EAX
ADD    EDX, 00000002
MOV    EAX, 00000022
OUT    DX, AL                                ; STROBE+ AUTO- INIT- SLCTIN+
MOV    EAX, 00000022
OUT    DX, AL                                ;
MOV    EAX, 00000024
OUT    DX, AL                                ; STROBE+ AUTO+ INIT+ SLCTIN+

```

D. Send DSO command:

```

LEA    ESI, DWORD PTR [EBP+08]              ; port
MOV    EDX, DWORD PTR [ESI]
ADD    EDX, 00000002
MOV    EAX, 00000006
OUT    DX, AL                                ; STROBE+ AUTO- INIT+ SLCTIN+
LEA    ESI, DWORD PTR [EBP+08]
MOV    EDX, DWORD PTR [ESI]
LEA    ESI, DWORD PTR [EBP+0C]
MOV    EAX, DWORD PTR [ESI]
OUT    DX, AL                                ; write command byte
OUT    DX, AL                                ;
OUT    DX, AL                                ;
ADD    EDX, 00000002
MOV    EAX, 00000006
OUT    DX, AL                                ; STROBE+ AUTO- INIT+ SLCTIN+
MOV    EAX, 00000007
OUT    DX, AL                                ; STROBE- AUTO- INIT+ SLCTIN+
MOV    EAX, 00000006
OUT    DX, AL                                ; STROBE+ AUTO- INIT+ SLCTIN+
OUT    DX, AL                                ;
MOV    EAX, 00000026
OUT    DX, AL                                ;
MOV    EAX, 00000024
OUT    DX, AL                                ; STROBE+ AUTO+ INIT+ SLCTIN+

```

E. Load DSO data (CH1):

```

LEA    ESI, DWORD PTR [EBP+08]              ; port
MOV    EDX, DWORD PTR [ESI]
ADD    EDX, 00000002
MOV    EAX, 0000002A                          ; (28 = AUTO+ for CH2)
OUT    DX, AL                                ; STROBE+ AUTO- INIT- SLCTIN-
MOV    EAX, 0000002B                          ; (29 = AUTO+ for CH2)
OUT    DX, AL                                ; STROBE- AUTO- INIT- SLCTIN-
LEA    ESI, DWORD PTR [EBP+08]
MOV    EDX, DWORD PTR [ESI]
IN     AL, DX                                ; read data byte
AND    EAX, 000000FF
MOV    EBX, EAX
ADD    EDX, 00000002

```

```
MOV    EAX, 0000002A                ; (28 = AUTO+ for CH2)
OUT    DX, AL                       ; STROBE+ AUTO- INIT- SLCTIN-
LEA    ESI, DWORD PTR [EBP+0C]
MOV    ESI, DWORD PTR [ESI]
MOV    DWORD PTR [ESI], EBX
```

Notes:

- to load CH2 data substitute hex 28/29 for hex 2a/2b.
- data after a 5000-sample acquisition for one input channel consist of 500 points selected according to the readout1 step parameter, followed by 500 points selected according to the readout2 step and shift parameters, followed by the bytes hex 01, hex fe, and hex 80, followed by a repeat of points 301 through 400 from readout2.
- the original 5000 samples are available after hex 2000 bytes (8 kB); the intervening and subsequent bytes are mostly set to a pattern of hex 00 and ff (presumably the power-on state); the whole data repeat after hex 4000 bytes (16 kB).
- readout1 starts at the 1st point of the original data and proceeds in steps of readout1 step; readout2 starts at the original data point selected as the (n+1)th point of readout1 and proceeds in steps of readout2 step, where n is the value coded by the readout2 shift parameter.
- data are retained in the acquisition RAM until overwritten: when acquisition / reselection is on hold, Load Data delivers the previous data; after an acquisition break, it delivers part new and part old data.
- during scroll acquisition, data points are loaded one at a time (scroll acquisition timing is determined by the host data requests!); data in the acquisition RAM are not affected.

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