Casio PB-2000C Overclocking
Replace 910 KHZ Oscillator

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Introduction

This document describes the hardware modifications required to increase the operating frequency of the PB-2000C by replacing the original 910 kHz oscillator on the mainboard with a 2 MHz oscillator.

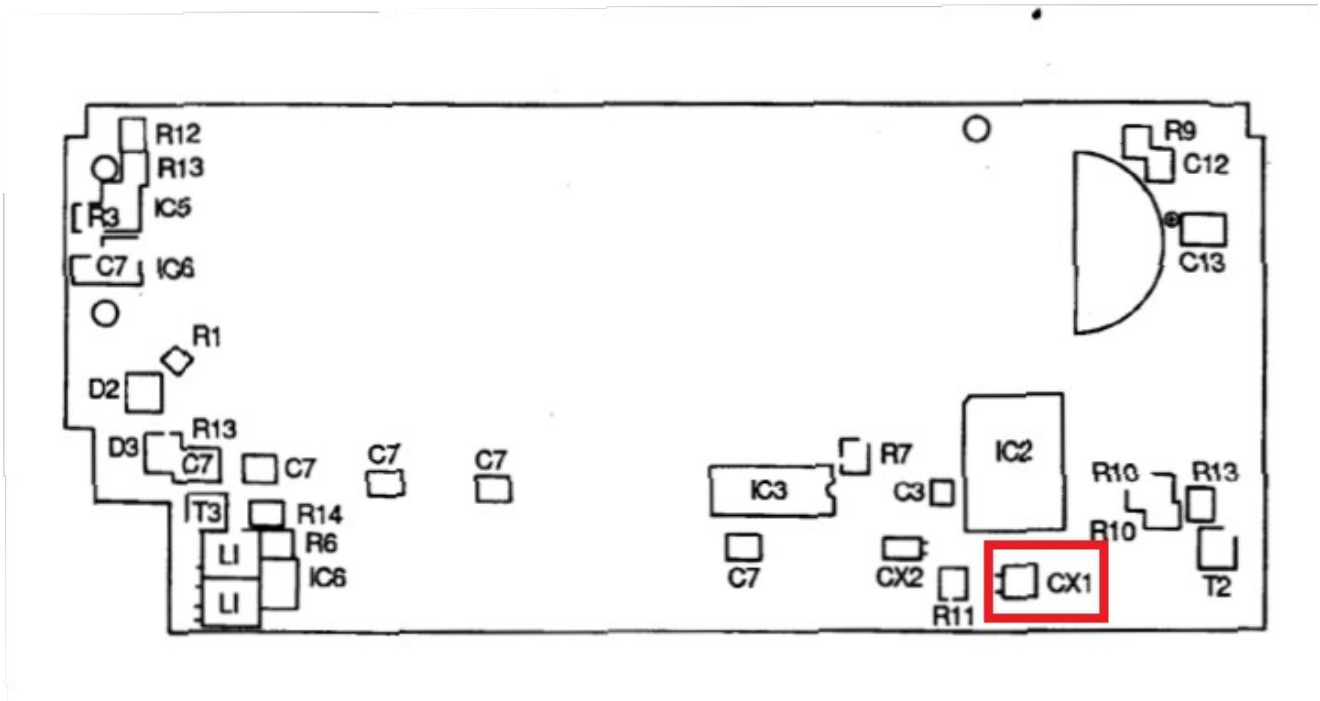
This work was developed jointly by Alex Barragan and ChatGPT, through a cycle of ideas, implementation, execution, observation, and revision. It illustrates how human knowledge and experimentation combined with AI-assisted analysis can produce results that neither participant would readily achieve alone.

Component Location

The PB-2000C Service Manual page 22 describes the original part.

D1	2301 2324	Chip doide	MA151K	1	10	24	C
D2	2315 0212	Chip diode	MA153-(TX)	1	20	27	C
D3	2390 0035	Schottky diode	SB007-03CP-TB	1	20	18	C
CX1	2590 0049	Ceramic oscillator	CSB910D	1		95	C
R1	2606 0042	Carbon film resistor	R-20-10K-J	1	20	2	C
R2*Q	2795 0476	Chip resistor	MCR10PZHJ333	2	20	2	C

At location PCB-V540-1 CX1.



This document follows Casio's original nomenclature and refers to the CSB910D as an **oscillator**, as it is identified in the period Casio documentation. In modern terminology, the component itself would more commonly be described as a **ceramic resonator**, forming the frequency-determining element of the oscillator circuit. The term *oscillator* is retained throughout this document for consistency with the original Casio documentation.

The **CSB910D** part number is consistent with Murata's historical **CSB series of CERALOCK® ceramic resonators**, suggesting that the original 910 kHz component used by Casio was manufactured by Murata. Contemporary Murata documentation describes the CSB family as ceramic resonators intended, among other applications, for microprocessor clock circuits. The original CSB910D itself has not been located in the available catalogs, so the Murata attribution should be regarded as tentative rather than definitive.

The PB-2000C uses two separate oscillators, each serving a different function. CX1 provides the approximately **910 kHz system clock** through the HD61700's **OSCI/OSCO** pins (31 and 32), while CX2 provides the **32.768 kHz clock** through the **XI/XO** pins (29 and 28). This identification, initially inferred from the schematic, component markings, and HD61700 pin assignments, was subsequently confirmed by Piotr.

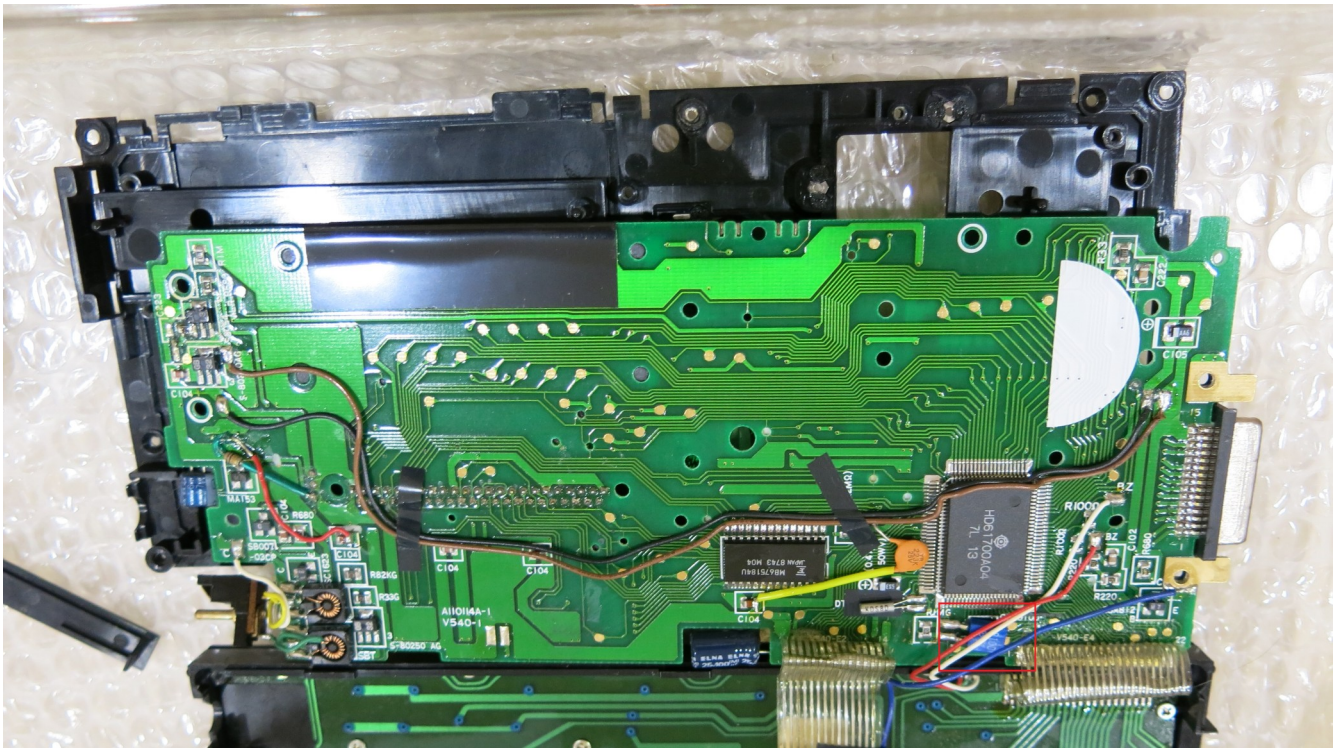
The modification described here affects only CX1 and therefore changes the processor clock without altering the independent 32.768 kHz clock provided by CX2.

Three-Terminal Oscillators

During the development of this document, the use of a three-terminal ceramic oscillator/resonator was considered. These devices incorporate the required load capacitors internally, with the center terminal connected to ground, and can therefore simplify oscillator circuits that otherwise require external capacitors.

This approach is **not required for the PB-2000C**. Although the capacitors are not apparent in the photographs, the PB-2000C already provides the required oscillator capacitance on the mainboard. A conventional two-terminal ceramic resonator can therefore be used as the replacement, preserving the original circuit arrangement.

Field of Work





CX1 is located immediately under the HD61700 processor. Several interconnecting lead wires pass over the component; these have sufficient slack to be gently moved aside and temporarily secured with Kapton® tape, providing unobstructed access to CX1 without disturbing their connections.

Modifications

The replacement oscillator is a Murata CERALOCK® 2 MHz ceramic resonator, CSALF2M00G55-B0 (formerly CSA2.00MG, discontinued in April 2014[1]). It is a two-terminal, non-polarized component and may therefore be installed in either orientation.

With the lead wires safely moved aside and secured, confirm that the work area around **CX1** is clear and readily accessible.

- **Carefully desolder and remove CX1**, using only the heat and mechanical force necessary to free its two leads. Avoid stressing the PCB pads or traces.
- With CX1 removed, inspect the pads and surrounding traces. Verify continuity from each CX1 pad to its corresponding **HD61700 OSCI/OSCO connection (pins 31 and 32)**, and confirm that the two CX1 pads are not shorted together.
- **Preserve the original CX1.** Do not discard or modify it; label and store it safely so that the PB-2000C can be returned to its original 910 kHz configuration if desired.
- Inspect the two pads and surrounding traces for damage, and **clean the work area** of residual flux or excess solder as appropriate.
- Install the **2 MHz replacement oscillator** in the original CX1 position. For a **two-terminal ceramic resonator, orientation is not significant**; the component is non-polarized.
- Solder both leads, keeping the joints brief and controlled. Inspect the completed joints for proper wetting and for solder bridges or damage to adjacent traces.
- Inspect both solder joints carefully and verify that no adjacent traces or connections have been disturbed.
- Allow the area to cool and perform a final visual inspection of the new CX1 installation.
- Remove the temporary Kapton tape and **carefully return the interconnecting lead wires to their original routing over CX1**, taking care not to place unnecessary tension on their soldered connections.

1 Pedantically, ChatGPT insisted on “March 31, 2014”, sure.

Testing

The first operational test is simply to verify that the modified PB-2000C powers on and operates normally.

Having two PB-2000C units available—one in its original configuration and one modified as described here—will be particularly useful, allowing direct side-by-side comparison under identical conditions.

Continued testing on the actual hardware will establish the detailed performance characteristics of the modification. This section will therefore be expanded as quantitative performance measurements become available.

Put the two PB-2000Cs side by side and watch the cursors.

If the cursor timing is derived from the processor clock, the modified machine's cursor will blink noticeably faster—an immediate visual indication that the 2 MHz oscillator is actually affecting the system.

Simply using the two machines side by side should also reveal whether menu navigation, screen updates, and general responsiveness feel noticeably faster on the modified PB-2000C.

The auto-power-off interval should remain unchanged, since its timing is expected to be derived from the independent 32.768 kHz clock provided by CX2. This can be verified by comparing the original and modified machines.

A Soprano Prognostication

Piotr, who has an unsurpassed knowledge of this device, intuited that the pitch for the 2 MHZ machine sound would be higher because it is likely controlled by CX1.

Next, a simple test, on both devices enable the beep on key press.
Press MENU and press the Etc. key until you see this screen



Press the third function key for [set]

and select Y on the first field (key beep)



and press [EXE]

We speculate that sounds will be approximately 2.2 times higher in frequency—a little over an octave higher to the trained ear. Ironically, this cannot be tested using the emulator, as it does not yet support sound.

At 2.2 times the original frequency, the resulting tone would be slightly more than one octave higher—the PB-2000C may acquire something of a soprano voice.

Relative Performance Testing using DL-Pascal 1.2

This section requires a modified PB-2000C, an FA-7 unit to facilitate transfer of the benchmark program, and basic familiarity with the DL-Pascal 1.2 environment. The FA-7 is used for convenience; the benchmark program is sufficiently short that it may also be transcribed manually.

Follow the NEWALL and RESET sequence. Insert a suitable probe through the access openings and gently depress the internal push buttons.

Save the program as hd61time.pas.

```
PROGRAM GetTime;
USES Crt;
VAR
  Minutes : Word ABSOLUTE $06A9; { Appendix F p.319 }
  M1,M2   : Word;
  S1,S2   : Word;

FUNCTION GetTM : Word;
BEGIN
  INLINE(
    $1F,$68,             {       GST TM,$8          ; first TM reading       }
    $02,$69,$08,         { L1:   LD  $9,$8          ; save previous reading  }
    $1F,$68,             {       GST TM,$8          ; read TM again          }
    $01,$68,$09,         {       SBC $8,$9          ; compare the two reads  }
    $B4,$89,             {       JR  NZ,L1          ; repeat until identical }
    $42,$09,$00,         {       LD  $9,0           ; make result a Word     }
    $42,$04,$04,         {       LD  $4,4           ; result offset = IX-4   }
    $A0,$E8,$04);        {       STW $8,(IX-$4)     ; return stable TM value }
END;

{
TM is an 8-bit timer with two fields:
   bits 7-6 : 4-minute count, 0..3
   bits 5-0 : seconds count, 0..59
}
BEGIN
  M1 := Minutes;
  S1 := GetTM AND $3F;
  WriteLn('Start: ',M1,' min ',S1,' sec');

  TimerStart(0,300);
  WHILE NOT TimerOut(0) DO ;

  M2 := Minutes;
  S2 := GetTM AND $3F;
  WriteLn('End:   ',M2,' min ',S2,' sec');
END.
```

After successfully compiling the program run it on the baseline 910 kHz machine. The following is a sample result from the emulator.



Your result will vary, what really matters is the time difference. 36 seconds in this case.

Follow the same procedure on the modified 2 MHz machine.



Your result will vary, what really matters is the time difference. 17 seconds in this case.

Increasing the system clock from 910 kHz to 2 MHz represents a theoretical frequency increase of 2.198 times. The same DL-Pascal timer interval measured 36 seconds on the original machine and 17 seconds on the modified machine, corresponding to a measured ratio of 2.118 times. The close agreement demonstrates that the DL-Pascal timer interval scales substantially with the system clock in the emulated environments, rather than remaining tied to the independent 32.768 kHz timekeeping clock, **providing solid experimental evidence of the performance increase achieved by the modification.**

Running on the author's PB-2000C produces the satisfying result of 34 seconds. Consistent with the emulator's result.



Effect on Power Consumption and Battery Life

This section has not been peer reviewed yet.

Increasing the PB-2000C system clock from 910 kHz to 2 MHz can be expected to increase power consumption and consequently reduce battery life. The magnitude of this effect, however, cannot be determined simply from the increase in clock frequency.

For CMOS logic, dynamic power consumption is approximately proportional to operating frequency: $P_{dynamic} \propto C \times V^2 \times f$

Since the modification does not change the supply voltage, the clock-dependent portion of the circuitry could therefore consume approximately: $2.000 \div 0.910 \approx 2.20$ times its original dynamic power. If the entire power consumption of the PB-2000C were dependent upon the system clock, this would reduce theoretical battery life to approximately: $1 \div 2.20 \approx 45.5\%$ of its original value.

This represents a pessimistic limit rather than a prediction. The PB-2000C contains loads that do not necessarily scale with the system clock, including the LCD, static circuitry, power-supply losses, and the independent 32.768 kHz timing subsystem. A more useful model is therefore: $P_{new} = P_{fixed} + 2.20 \times P_{clocked}$.

For example, if one half of the original power consumption were attributable to clock-dependent circuitry, the total consumption would increase by approximately 1.6 times, leaving about 62% of the original battery life. If the clock-dependent portion were only 30%, approximately 74% of the original battery life would remain.

These calculations illustrate the expected behavior but cannot establish the actual power consumption of the modified PB-2000C. Increasing the system clock will reduce battery life, but there is no reason to assume that doubling the clock frequency will simply halve it.

The effect should therefore be determined experimentally. The battery current of the same PB-2000C can be measured by inserting an ammeter in series with the battery supply. Measurements should be taken at both 910 kHz and 2 MHz under two representative operating conditions.

Interactive operation represents normal use of the PB-2000C: the computer is switched on, DL-Pascal is active, and the user is editing a program or entering text at normal human typing speed. During this type of use the processor spends considerable time waiting for keyboard input, and the clock-dependent increase in power consumption may represent only part of the total energy consumed.

Continuous computation represents the opposite case. The computer executes a repeatable computational workload continuously, keeping the processor active and providing a better indication of the maximum practical effect of the increased system clock.

Because the batteries and their nominal voltage remain unchanged, the ratio of the measured currents provides a direct indication of the change in power consumption:

Power ratio ≈ $I_{2\,MHz} \div I_{910\,kHz}$

The corresponding change in battery life can then be estimated approximately as:

Battery-life ratio ≈ $I_{910\,kHz} \div I_{2\,MHz}$

Separate measurements for interactive operation and continuous computation are important because a PB-2000C used primarily for editing and occasional calculations may experience a substantially different battery-life penalty from one performing continuous computation. These measurements would replace the theoretical estimate with results from the actual machine and establish the practical cost of operating the PB-2000C at 2 MHz.

Future Benchmark ROM

DL-Pascal 1.2 provides a convenient environment for relative performance testing, but it is not an ideal basis for a generally reproducible benchmark because of its limited availability. One avenue for future work is therefore to implement the benchmark as a self-contained, bootable ROM image, distributed on an OM-64R-compatible ROM card. This would follow the tradition of Casio's OM-32 diagnostic ROM used with the PB-2000C, while providing a readily reproducible hardware-level performance test independent of DL-Pascal.

As of revision 4 of this document a ROM version of a tiny performance monitor can be found here.

Field Experience – Ghosting



Daniel, our tech, installed the 2000 kHz Murata resonator on our test PB-2000C. He documented screen ghosting, as shown in the picture on the left.
Silicium user Xerxes reports having three overclocked units showing no such issue, so it is possible that this problem is unique to this particular unit.

I mentioned this issue to Piotr, recalling something similar in Sharp models overclocked above 1500 kHz. His verbatim remark:

> "The LCD display might not tolerate being driven by waveforms with increased frequency. Such a problem likely wouldn't occur in the PB-700, which has a separate resonator for the LCD subsystem."

We will install a slower resonator—the 1.5 MHz muRata CSALA1.500MK (CSA1.500MK Ceramic Resonator CERALOCK)—and check the performance of the LCD. We also have other units and will try the 2000 kHz modification on them.

Acknowledgments

This User Guide was produced by Xandrian Labs. 付喪神.

Special thanks to Piotr and Betka for their continued and unwavering support.

This is a collaboration with ChatGPT. All errors are human.

This work is freely shared with the vintage computing community. Please use it, build upon it, and cite the source.

Revision 5.