Chapter 8

Discussion and Summary

In this chapter, the discussion on the encountered problems is presented. The problems are discussed mainly on hardware section especially in digital parts. The summary is also included at the end of chapter.

Discussion

In building the signal averager, many problems arise in the hardware part. The problems are separately discussed in each part. Some suggestions in hardware modification are also provided in order to improve the capabilities of the signal averager which are only limited by the devices used in the design. Since the hardware section of signal averager is designed as five separate units, any modifications in each unit can be easily done.

For the TMS320 part, since the required memory with fast access time of under 100 ns is not available then decreasing in execution speed of TMS32010 is used to solve the problem. This limitation can be override by using a faster memory chip and changing the crystal oscillator. However, delay time in digital gates should be considered when fast memory chips are used. In the design, the digital gates in low-power schottky (LS) series which have typical delay time about 9 ns are used. For higher frequency in instruction cycle, advanced low-power schottky (ALS) series which have 5 ns of delay time can be used to replace the mentioned LS series.

Another problem is the limitation of data memory capacity that can be directly accessed from the TMS32010 which we use external memory technique as a solution. However, this prevents the modification of software to serve more comprehensive processing algorithm especially on the memory-sensitive one such as 2 dimensional FFT. The solutions of this restriction came in many aspects differentiated by time, cost, and other factors. An appropriate way is changing the DSP to a more powerful one. Texas Instruments Inc. which is the producer of TMS32010, presents a number of powerful DSPs in the recent years. Interestingly, a more powerful TMS32020 which is the second generation of TMS320 family is brought out. The problem on the limitation of memory capacity has been solved in TMS32020. Moreover, as a member of TMS320 family means that with a little modification on software TMS32010 can be substituted by TMS32020 in most of applications.

In the memory part, the bus-width is limited at 16-bit. This configuration is used in order to simplify the interfacing circuit with TMS320 part. Consequently, this limits the maximum number of sweeps. For the applications in which signal-to-noise ratio is significantly depended on the number of sweeps, the memory-width can be widen to 32-bit. Since the internal architecture of TMS32010 is based on 32-bit width, no physical modification is necessary if decreasing in memory capacity can be accepted. By modifying the TMS320 program to take a full capability of 32-bit instruction, the data memory bus is logically widened into 32-bit. The memory capacity is also reduced into 16k words. To conserve the 32k words capacity in the 32-bit width configuration, other 32k words of 16-bit width memory chips must be added.

For the analog part, operational amplifiers are used mainly in the circuit. Thus, the efficiency of analog part is depended on the specifications of the operational amplifiers being in used. In sample-and-hold circuit, an operational amplifier with very low input bias current is required. A LF357 which is the lowest input bias current operational amplifier available in the local market is used in the design. The result is good but the risetime of acquired signal can be improved by replacing LF357 with a less input bias current one. An operational amplifier with 15 pA in input bias current is sufficient.

Summary

The experimental work gives the satisfactory result. This signal averager is suitable for NMR imaging research or other researches that make use of its functions. However, customizing for other applications is simple and easy because the operations is mainly in the software. The control program can be modified to satisfy the specific requirement by any programmer which has some experiences in BASIC programming language.