

A Low-Cost Magnetic Resonance Console for Process Line Monitoring and Point of Sale Testing

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Introduction

- A key component of any Magnetic Resonance system is the electronics responsible for producing and collecting the signals sent to and received from the sample.
- This is typically referred to as the spectrometer in systems capable of spectroscopy or console in those which are not, and comprises a number of individual subsystems [1].
- Most systems are designed with maximum versatility in mind and thus are expensive.
- For many applications, particularly process line monitoring and point of sale testing, the samples and hardware are well defined and thus this versatility is unnecessary.
- This opens up the possibility of a low-cost console which is based on a narrow range of possible parameters using low specification electronics and driven by simple microcontroller.

System Design

- The system comprises a number of blocks as would be expected in any NMR console as can be seen in Figure 1.
- However digitising the signal in the final stages requires more expensive analogue to digital converters than are typically found in microcontrollers, or requires the use of a second microcontroller dedicated to acquisition.
- Instead in this system we also include an integrator module after the detector which integrates over the echo window, producing a DC voltage proportional to the echo amplitude.
- The system is designed as a set of stacking printed circuit boards, one for each module to facilitate its use for teaching applications, allow students to see the signals between each board for a greater understanding.

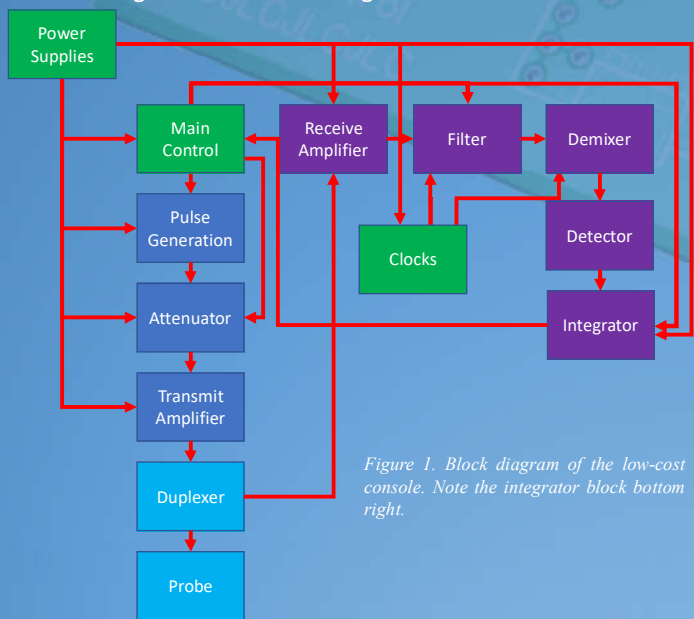


Figure 1. Block diagram of the low-cost console. Note the integrator block bottom right.

System Boards

- Some example modules can be seen in Figure 2 along with the assembled stack forming the complete console.
- The total cost of the current design including PCB manufacture is less than €150.



Figure 2. Example boards from the low cost console. Clockwise from top left: Main board, two stage capacitive filter, clock module, completed stack, demixing module and power supply module.

Integration

- The integration of the echo window allows acquisition of a single DC value per window for the microcontroller allowing use of lower cost versions which are easily programmed for a single purpose.
- Figure 3 shows the principles of integration.

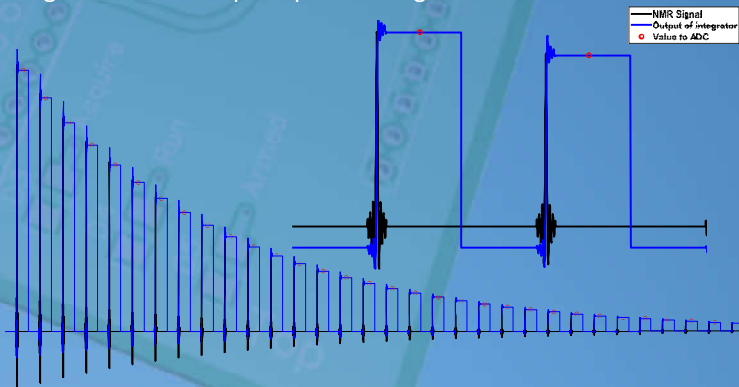


Figure 3. Black is the NMR signal output from the demixer or detector board. Blue is the output of the integrator while the red circles represent the value read in by the microcontroller.

Conclusion

- This low cost system has been developed to couple with low cost probes allowing for measurements at the point of manufacture or at the point of sale.
- The frequency of the console is fixed and a single experiment can be run, for example a CPMG as discussed here.
- Automated processing of the results by the microcontroller can be used to provide a red light green light result for a given process.

Acknowledgments

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References

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