

PRODUCT PERFORMANCE SPECIFICATION

MODEL NAME: Pump Controller Module

INSTRUMENT PART NUMBER: 200341

PROJECT MANAGER: *Fred Jones* DATE: *3/11/91*

MARKETING PRODUCT MANAGER: _____ DATE: _____

APPROVED BY: *B. Spearin* DATE: *3/11/91*

DATE: _____

DATE: _____

CONTROL NUMBER: 200454 *DMC 3-8-91*

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1.0 General Information

1.1 Introduction

The Waters Pump Control Module (PCM) is designed to provide a low cost solution for pump control in a chromatography system. The system is functionally identical to a SIM module with a CPU card and one Pump board installed. The same firmware used in the SIM module is used verbatim in the PCM. There are several minor functional differences between the two systems which are noted as applicable in the following sections.

The PCM implementation utilizes high speed Complementary Metal Oxide Semiconductor (HCMOS) logic. This technology provides high performance with low power consumption. The PCM is packaged in a modular plastic enclosure and is powered by a regulated wall transformer resulting in a compact and power efficient design.

1.2 Applicable Documents

The following documents should be referenced for more information on the PCM and SIM module:

1. Logic Diagram, PCM #200453
2. Performance Specification, SIM Pump Board #087740
3. Performance Specification, SIM CPU Board #087741

2.0 Hardware Description

2.1 MPU

The PCM uses a Zilog Z84C00 4 MHz MPU. This is a CMOS version of the Z80 CPU used in the SIM module.

The 8 bit data bus is pulled up to +5 volts via a 1 K Ω resistor package (R38). This puts the data bus in a known state when the

firmware attempts to access SIM option cards which do not exist in the PCM. The pull-up resistors also prevent the data bus from floating when bus cycles are not executing. This minimizes the power consumption of the HCMOS devices.

The 4 MHz clock signal is provided by crystal oscillator Y2 and can be disabled for test purposes via jumper strap J7. The clock has a 10 Ω series dampening resistor (R41) to prevent undershoot and a 4.7 K Ω pull-up resistor (R39 pin 6) to enhance DC drive capability.

Address decoding for the entire PCM is provided by CMOS 20G10 PALs U36 and U41, as well as the low power 16L8Q PAL, U35.

2.2 Memory

The memory in the PCM is comprised of one 8K x 8 27C64 EPROM (U31) and two 32K x 8 CMOS static RAMs (U26 and U30).

When the PCM is reset, the EPROM is mapped into the lower 8 Kbytes of the memory map. The SRAM occupies the remainder of the 64 Kbyte memory space. The firmware startup diagnostic copies the contents of the EPROM into SRAM and then compares the two memory images. If the images match, the EPROM data is copied into the lowest 4 Kbytes of SRAM, which overlaps the EPROM area. The ROM/RAM bit is then set, which disables EPROM and maps SRAM to the entire 64 Kbyte memory address space.

2.3 Counter/Timer Circuit

The Counter/Timer circuit consists of a Zilog Z84C30 CTC chip (U27). This chip is used to provide all of the system time references for the PCM. This chip generates an interrupt to the MPU.

2.4 IEEE-488 Interface (GPIB)

The GPIB interface is comprised of the Texas Instruments TMS9914A Controller (U43), the 75160 transceiver (U37) and the 75161 transceiver (U28). The TMS9914A generates an interrupt to the MPU.

The connector for the GPIB (J1) is located on the right rear of the unit.

2.5 I/O Control

I/O Control consists of the following elements: Event Outputs, Event Inputs, Front Panel Indicators, and GPIB address switches. An Intel 82C55A Programmable Peripheral Interface chip (U17) is used to control all of the functions described in this section.

2.5.1 Event Outputs

The PCM has the capability of generating six event outputs. All six of these outputs are relay driven (RL1 - RL6). *This is a change from the SIM where four of the Event Outputs are TTL driven and two are relay driven. The front panel is labelled "Relays" and "Events" to match the SIM module nomenclature.* The Event Outputs are accessible through the front panel. The connectors (J2 and J3) used are modular terminal blocks identical to those used on the SATIN module.

2.5.2 Event Inputs

Event inputs are used to signal the PCM when to initiate a run and when to abort a run. These TTL level inputs are terminated with a parallel resistor network of 150 Ω (R32 - R35). Event inputs are connected to the PCM through the front panel terminal block (J2).

2.5.3 Front Panel Indicators

Two LEDs are used to indicate the PCM operating state. The first indicator is an amber LED (DS1) which is functionally equivalent to the Solvent Deliver Systems Status #1 LED on the SIM front panel. When the PCM successfully completes its startup diagnostics, this LED turns on and remains on continuously. This LED is labeled "OK" on the PCM front panel.

The second indicator is a green LED (DS2) labeled "RUN" on the PCM front panel. This indicator becomes active when a chromatography run is in process. It is functionally equivalent to the "Active" LED on the SIM front panel.

2.5.4 GPIB Address Switches

The DIP switch used for setting the GPIB address is located to the left of the GPIB connector on the rear panel. The address switches (SW1) are user accessible from the rear panel.

2.6 Pump Control Interface

The Pump control interface consists of three identical circuits used to independently control three separate pumps. Each pump control circuit consists of a speed control output, a pump status input and a pump pressure input. Pumps are attached to the rear panel of the PCM with Molex connectors (P1 - P3). These three panel mounted connectors are wired to the circuit board via a cable assembly which mates to a vertical Molex connector (J5) on the circuit board.

2.6.1 Pump Speed Control

Pump speed control is implemented using three independent digital frequency synthesizer circuits. The input clock frequency to the speed control circuits is derived from a 14.31818 MHz crystal oscillator (Y1). Two 82C55A chips (U16 and U29) are used to hold the incremental phase angle of desired pump

frequency for each circuit. The phase angle is summed in a phase accumulator every clock period. The phase angle and phase accumulator are 16 bit circuits. The summation is performed by a seventeen bit adder. The carry-out bit of the adder is the output frequency for the pump.

Full step or quarter step operation is controlled by the three speed selection bits S[1:3] in PAL U36. The default mode is full step operation.

[Note: Refer to the SIM Pump Board Performance Specification (087220) for more detailed pump speed control information.]

2.6.2 Pump Status

Each pump status input is terminated by a parallel resistor network consisting of three resistors (R10 - R18). These resistors scale the Pump Status input to 0 - 2.5 volts from ± 15 volts . The signals are then fed to the A/D converter (U14).

2.6.3 Pump Pressure

The pump pressure inputs are scaled by an inverting amplifier circuit which scales the signal levels to a range of 0 to +5 volts from -10 to 0 volts . The pressure inputs then go to the A/D converter.

2.6.4 Electrical Specifications

The following are the electrical characteristics of the pump interfaces:

Speed Control Output: +5 to -12 Volts

Status Input:	+15 Volts	(Pump OK)
	-15 Volts	(Over/Under Pressure)

Pressure Input: 0 to -10 Volts (0 to 6000 psig)

2.7 Diagnostic Indicators

The pump control module has an eight bit LED register (DS3) which the startup diagnostics access. These LEDs are controlled by PAL U42.

2.8 Reset

The reset circuit of the pump control module utilizes a CMOS version of the NE555 to generate a nominal 600 millisecond pulse when power is first applied to the unit. Additionally, software may trigger the reset circuit via a reset bit in PAL U41. *The PCM differs from the SIM in that when an Interface Clear (IFC) command is sent to the SIM over the GPIB, the entire SIM is reset. In the PCM, the IFC command merely resets the GPIB interface.*

3.0 Electrical Specifications

3.1 Power Supply

The pump control module uses a wall mounted regulated power supply. The supply enters the PCM through the front panel via J4. J4 is a DIN style five pin connector.

Inputs to the PCM are diode protected. The user, however, should always plug the power supply into the PCM before plugging the power supply into the wall. Damage to the PCM may result if power is inserted live.

The supply meets the following specifications:

Input Voltage (US): 105 - 129 VAC

Input Frequency (US): 60 Hz

Output Voltages:	+5 Volts @ 1 Ampere	(Pin 3)
	+12 Volts @ .2 Ampere	(Pin 5)
	-12 Volts @ .2 Ampere	(Pin 4)

Output Ripple: 10 millivolts maximum

AC Dielectric Strength (US): 1500 VRMS (1 minute)

3.2 Regulatory

The pump control module is designed to meet the following regulatory requirements:

UL
CSA
VDE

4.0 Environmental Specifications

Operating Temperature (Ambient) 0° to 40° C

Operating Humidity 20% to 80% (Non-condensing)

Storage Temperature -20° to 70° C

5.0 Mechanical Specifications

Weight: 1.85 lbs.

Dimensions:	width	6.33"
	height	2.59"
	depth	9.50"

A.0 Appendix

A.1 Memory Map

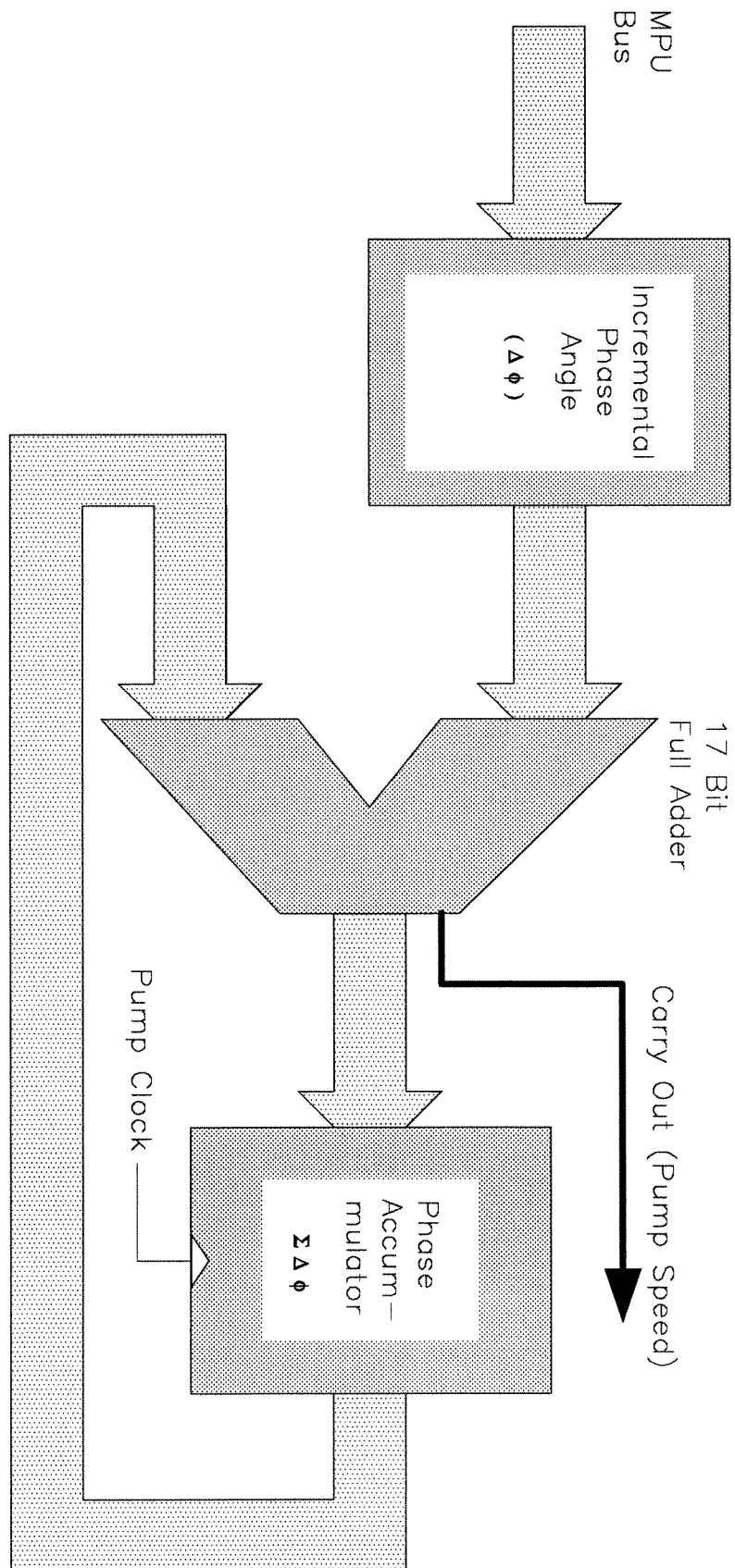
PROM_CS \$0000 - \$1FFF

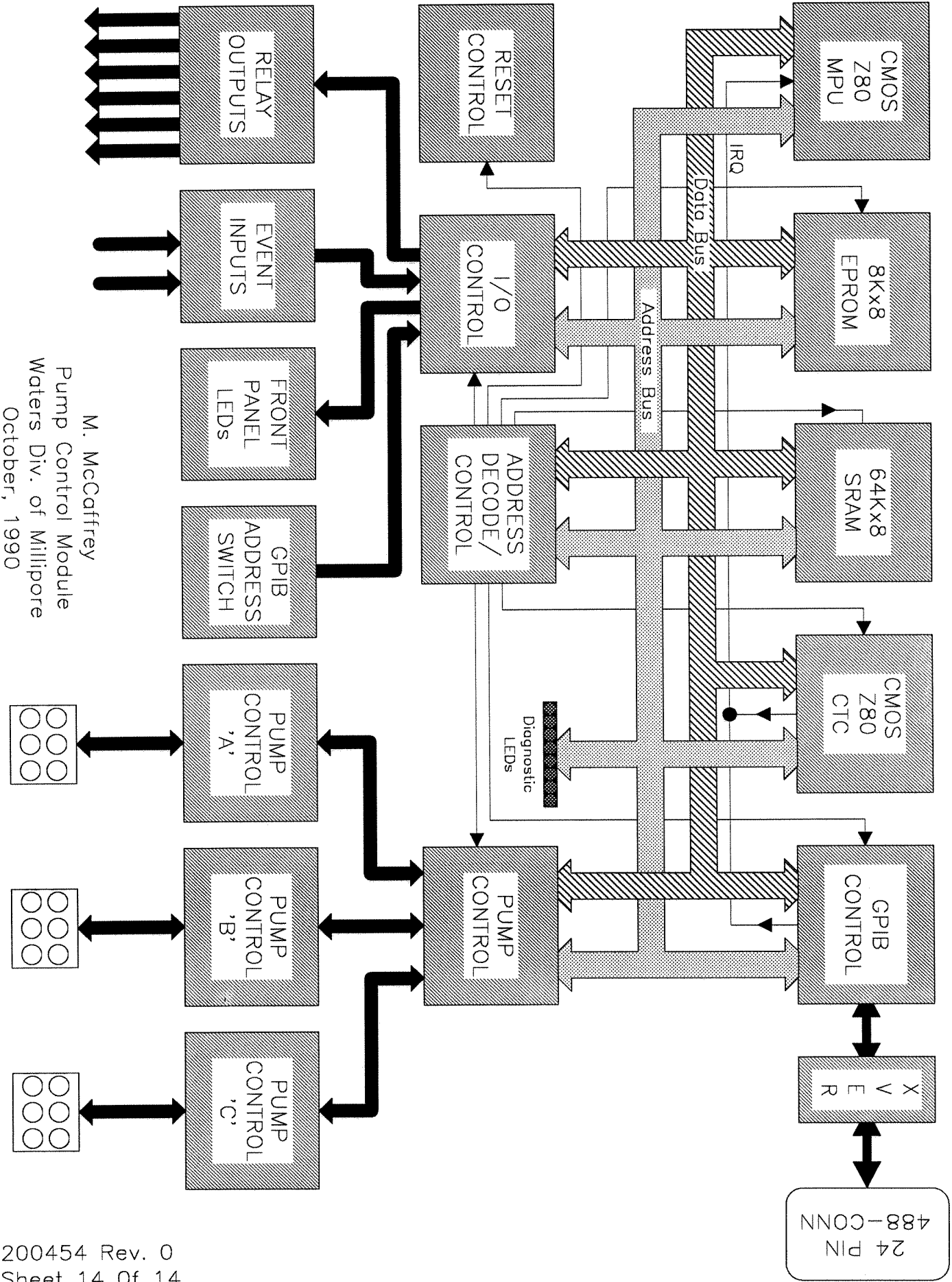
RAM0_CS \$0000 - \$7FFF

RAM1_CS \$8000 - \$FFFF

A.2 I/O Map

Speed Select Register	\$8C - 8F	W
A/D Enable		
Start	\$8B	W
ALE	\$8A	W
Output Enable	\$89	R
Status	\$88	R
PPI2	\$84 - \$87	R/W
PPI1	\$80 - \$83	R/W
Event Out Control	\$30 - \$37	R/W
Timer	\$20 - \$27	R/W
LED Register	\$18 - \$1F	W
IEEE 488	\$10 - \$17	R/W
ROM/RAM	\$08 - \$0F	W
SW Reset	\$00 - \$07	W





M. McCaffrey
Pump Control Module
Waters Div. of Millipore
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