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\$3.00 in United States
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Robot Experimenter™



A Voice-Controlled Robot System

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A Low-Power, General-Purpose Computer for Your Robot

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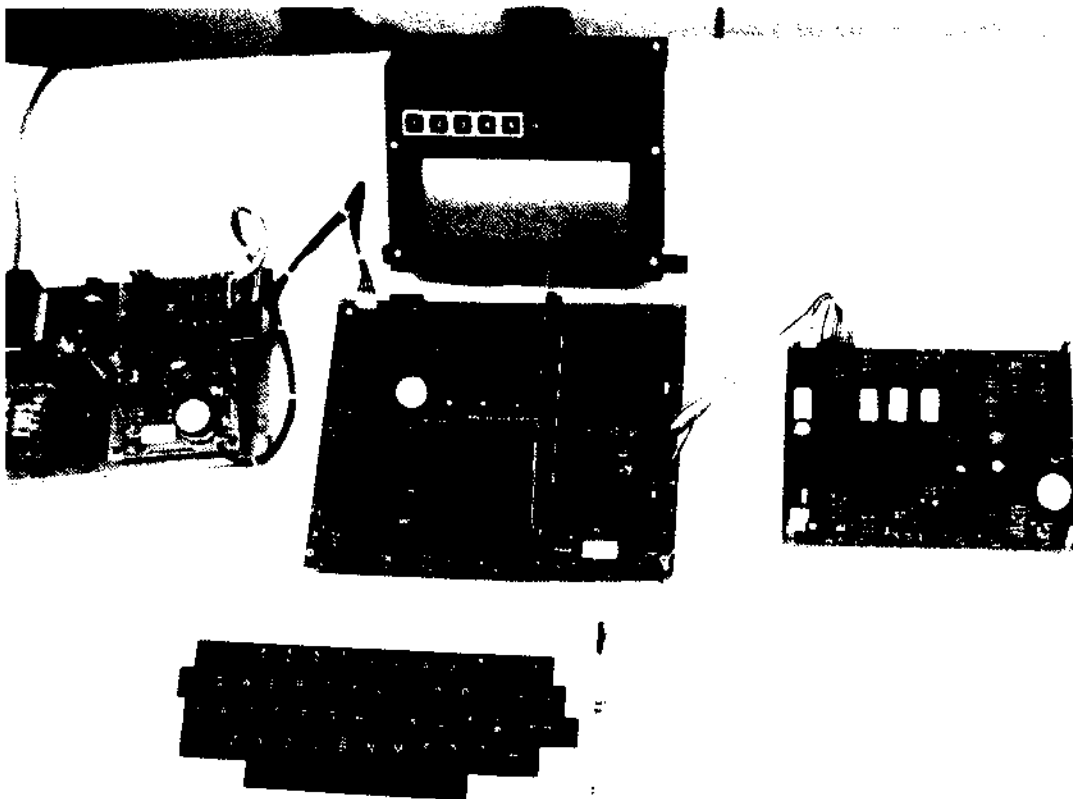
should not treat it lightly. Ask yourself many questions starting with general ones like, "What are the principal functions I want this computer to perform?" Then go on to more specific questions like, "How many bit inputs do I need and how will they be used?" It helps to have other designs available so you can see how someone else did it. That way, you can build upon the expertise and experience of other designers.

Table 1 lists most of the design specifications we developed for GEMINI's main computer. We attempted to minimize power consumption wherever possible. Why is this so important? Power consumption dictates the size of batteries required for a given number of off-charger hours of operation. Batteries are heavy and the heavier the robot, the more power required to move it

around. This in turn means larger batteries, which weigh more, and you find yourself in a vicious circle.

We selected the Rockwell 65C02 CMOS microprocessor because the first generation NMOS 6502 was very popular and there is a lot of software and design books available for this machine. The CMOS version consumes only 4mA of current compared to 90mA for the NMOS version running at 1 MHz.

The CMOS 65C02 also has an enhanced instruction set that allows you to write more compact (hence faster) code. We selected the Rockwell version over the GTE or NCR versions because the Rockwell has a more highly expanded instruction set.



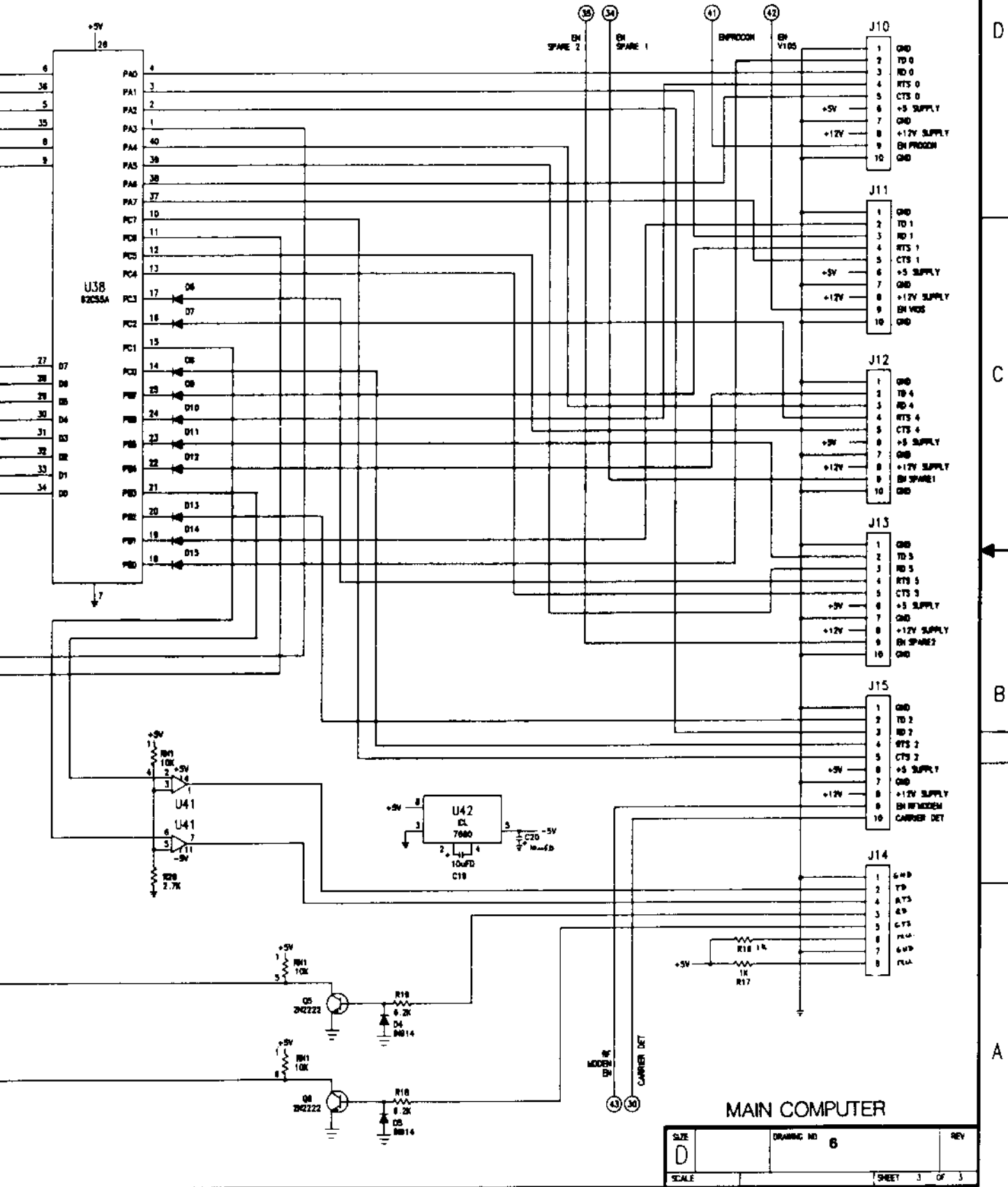
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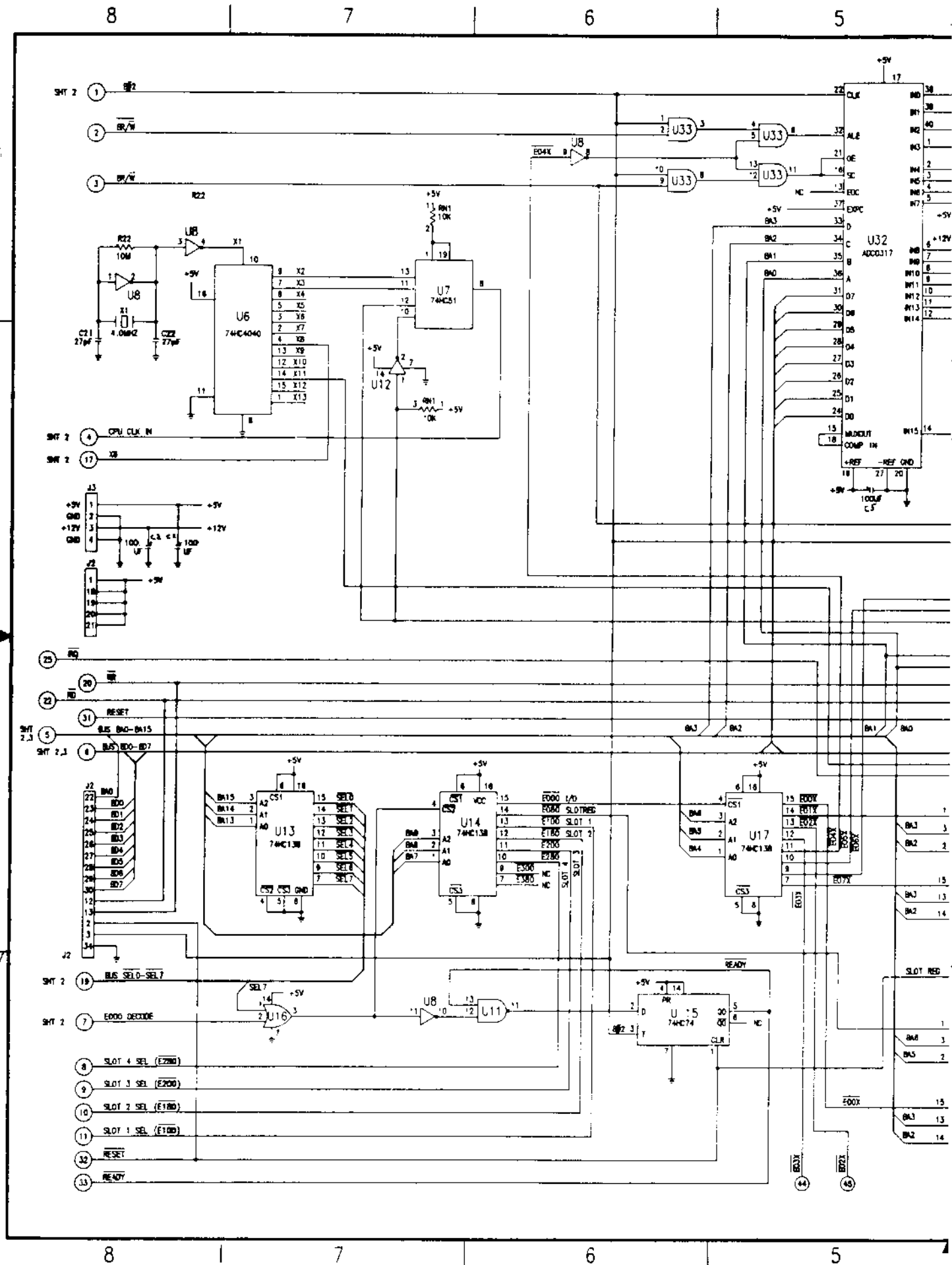
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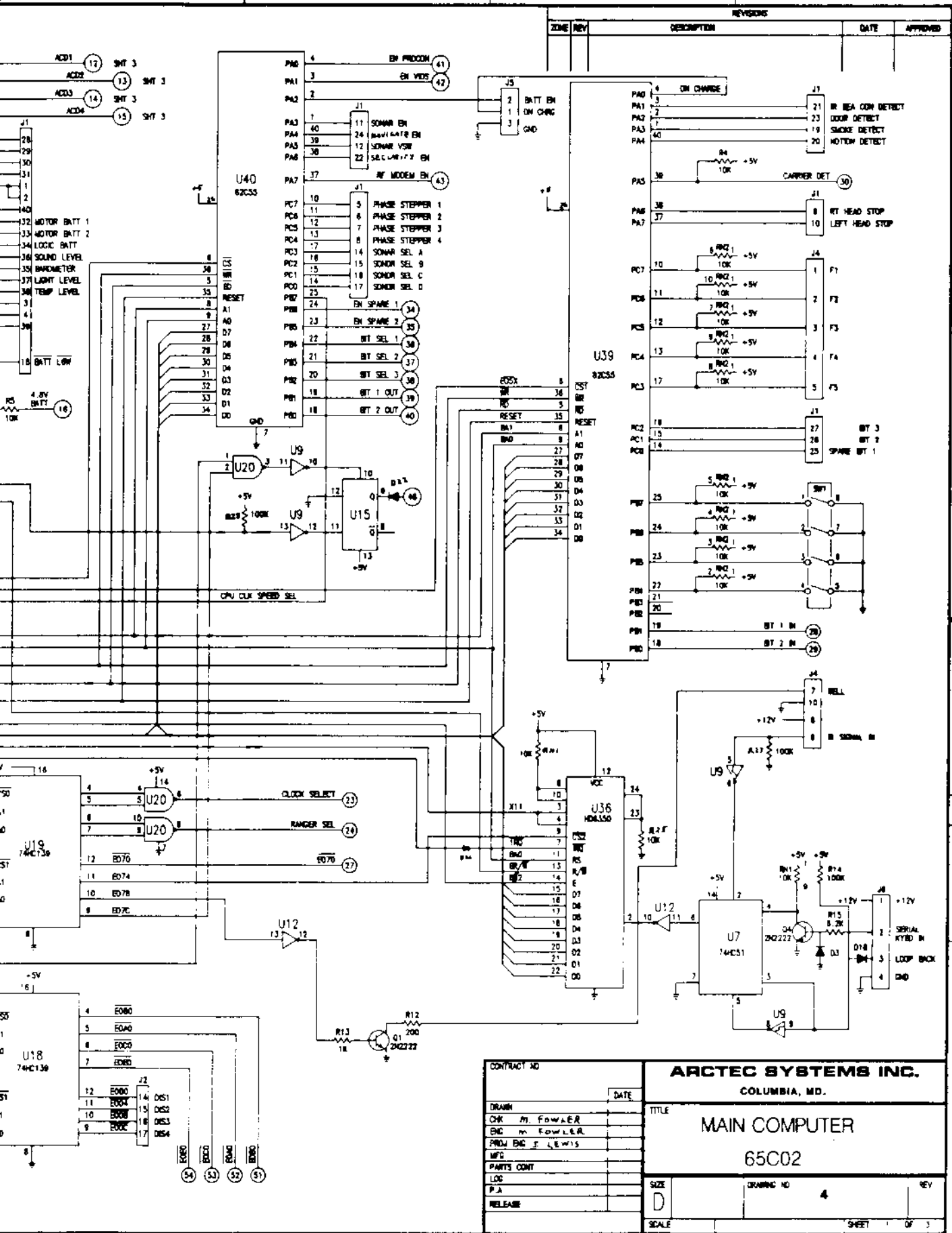
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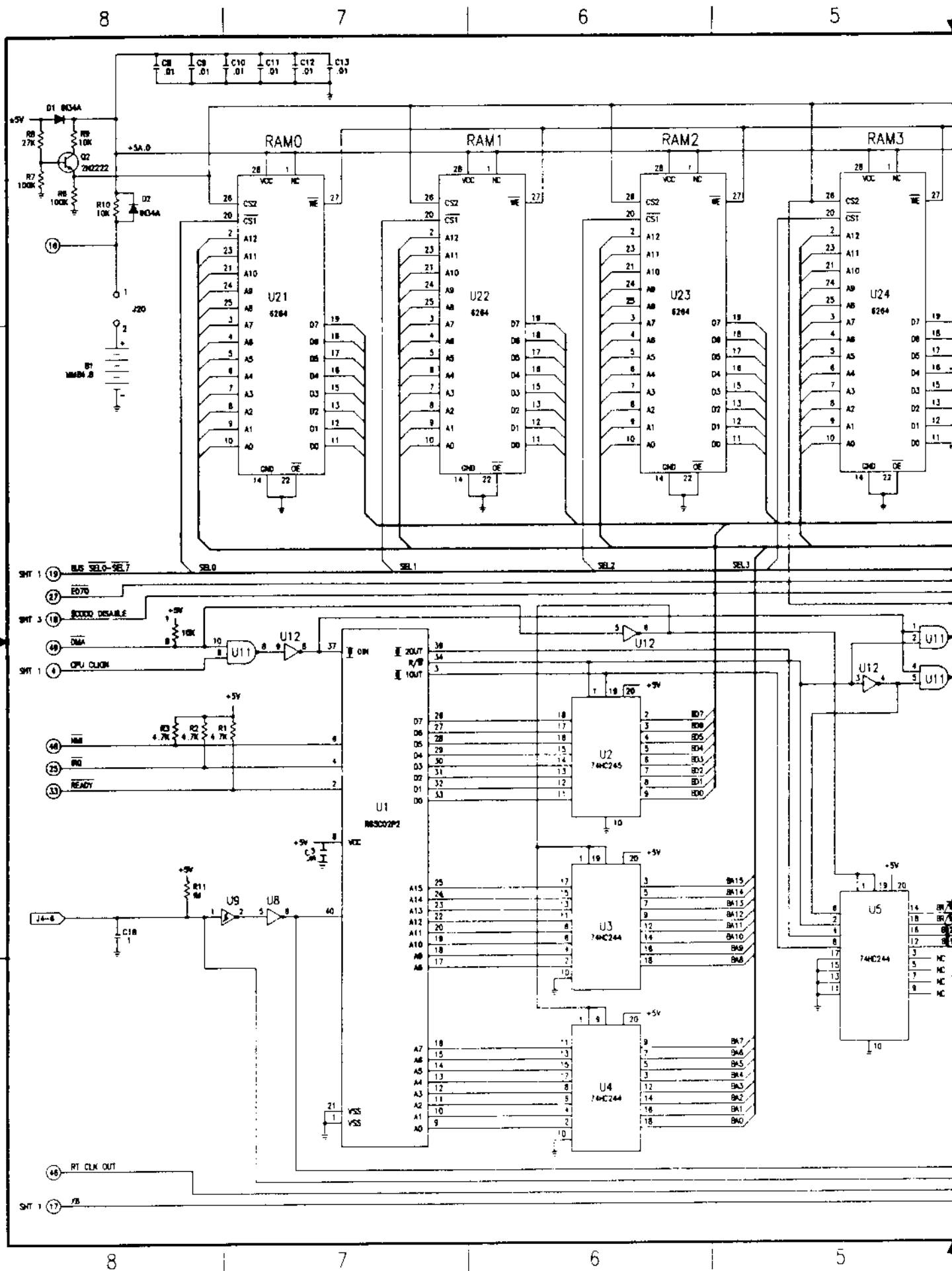




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ARCTEC SYSTEMS INC.	
COLUMBIA, MD.	
TITLE	
MAIN COMPUTER	
65C02	
SIZE	DRAWING NO 4
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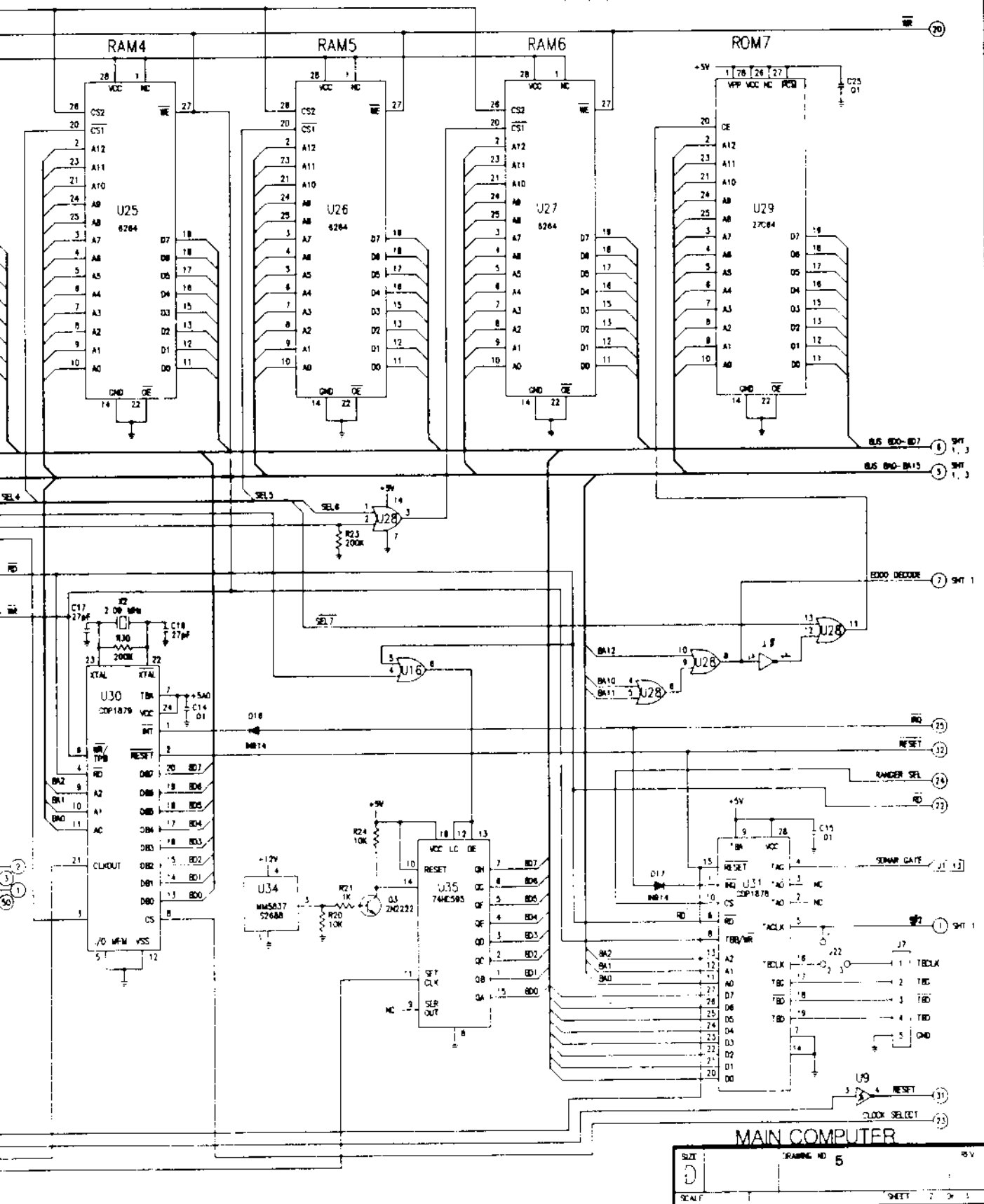
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MAIN COMPUTER

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The 65C02 is available in 1, 2, 3, or 4 MHz versions. We used the 2 MHz version and developed a scheme that allows us to alter the clock speed under program control. This saves power in operations such as wait loops (the 65C02 consumes 4 mA at 1 MHz) and still allows high-speed computations (the 65C02 consumes 8 mA at 2 MHz).

The 64 Kbytes of directly addressable memory space was split into 56 Kbytes of

user-programmable memory (RAM), 1 Kbytes of input/output (I/O) space, and 7 Kbytes of read-only memory (ROM) space. This provides lots of room for powerful ROM-based monitor software, ample room for I/O devices, and plenty of room for user-developed programs. We also provided the capability to bankswitch another 56 Kbytes of memory (RAM or ROM) into one of the 8 Kbyte RAM memory locations. We also selected static in lieu of dynamic programmable memory so it could be battery backed.

Table 1. Robot computer design specifications.

HARDWARE:

Microprocessor	- Rockwell 65C02 CMOS operation at 1 and 2 MHz
Programmable Memory	- 56 Kbytes of battery-backed static CMOS memory in 8 Kbyte packages
Read-only Memory	- 7 Kbytes onboard for monitor program
Input/Output	- 1 Kbytes for all I/O functions
Bank RAM/ROM	- 56 Kbytes of bank switchable RAM or ROM
Character Display	- Capable of driving an 8 line by 40 character LCD display
Clock	- Real-time clock with alarm interrupt capabilities
Counter/Timer	- Two 16-bit counter-timers
Serial Ports	- Six serial ports. One configured as RS-232C
Parallel Ports	- Two 8-bit wide I/O ports with handshaking lines. One configured as a Centronics printer port
A/D Converter	- One 16-channel, 8-bit CMOS analog-to-digital converter with less than 100 microsecond conversion time
Bit Input	- 24 digital input lines
Bit Output	- 24 digital output lines
Random Numbers	- Hardware generated
Character Input	- Capable of receiving ASCII characters serially from a terminal or smart keyboard
Bell	- Piezoelectric buzzer
Buffer	- All address, data, and control lines fully buffered
DMA	- Supports direct memory access
Expansion	- Four 50-pin connectors closely matching Apple II pinouts
Logic Family	- High-speed CMOS wherever possible

SOFTWARE

MONITOR COMMAND LANGUAGE:

- Single-letter commands to set and read the real-time clock, send and receive data on the dual parallel port, send and receive data on the RS-232C serial port, send output to a printer, enter bank RAM/ROM programs, and enter user programs.
- Single address commands to run a user program, disassemble code, display memory locations, and alter memory.
- Multiple address commands to output a range of memory to current output device, fill a range of memory with a given hexadecimal character, move a range of memory, and verify a range of memory.

UTILITIES

- Character output support for vectored character output. Separate LCD routines to support scrolling, etc.
- Auxiliary computer character I/O with separate input/output routines for each serial port with polling.
- Stepper motor driver routines to initialize a stepper motor, take one step, and take multiple steps.
- Sonar ranging routines to multiplex up to 10 sonars and take ranges on each.
- Processor speed selection routines to switch between 1 and 2 MHz
- Bank switching routines to handle bank-to-bank subroutine calls, jumps, fetching memory contents, and saving memory contents between banks
- Math pack provides 24-bit signed fractional integer math pack with trigonometric capabilities.