A LOW-COST DEVELOPMENT MODULE FOR THE R65F11 FORTH MICROCOMPUTER

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INTRODUCTION

The Rockwell R65F11 microcomputer implements a FORTH interpreter in a Rockwell R6500/11 single-chip microcomputer. With the addition of a Rockwell R65FR1 FORTH Development ROM the two-chip set is a complete FORTH development system. A module containing the R65F11, R65FR1, additional RAM memory, a terminal interface, and a floppy disk controller is all that is needed to provide a complete and inexpensive development and evaluation tool. This application note describes the design for such a module, complete with electrical schematic, printed circuit board layout artwork and parts list. In addition to hosting the R65F11 and R65FR1 devices the module contains an RS232 serial port, sockets for up to 16K bytes of RAM/ROM/PROM, parallel printer interface and a 5¼ in. floppy disk drive interface. The described development module can be easily fabricated using the artwork to build the printed circuit board.

In addition, artwork for a board to adapt an R65F12 into the development board is included. The three additional ports of the R65F12 are available via a connector on the adaptor board.

CIRCUIT DESCRIPTION

The R65F11 (U1) operates with a multiplexed address/data bus to access external memory. An external latch (U2) holds the address lines at the falling edge of EMS. The 555 timer (U5) generates a power-on-reset and the crystal oscillator circuit (U3) produces the master clock. Even though the R65F11 has an internal crystal oscillator, the 2 MHz signal generated by U3 is required by the floppy disk controller. A 256-by-8 bipolar PROM (U6) decodes the addresses and generates chip selects. The 74LS32 (U11) generates clocked chip select signals for the RAM devices. The use of the PROM facilitates changes in the memory map without changing the circuit. An example PROM pattern is given in Table 1 for a system consisting of 6K RAM (from $0200–$17FF) and 8K of ROM (from $2000–$3FFF).

Each of the memory sockets can be configured for a number of different memory devices by changing the position of the various jumpers as shown in Table 2. Socket U7 can be used with an 8K × 8 static RAM, 2764-type or 2732-type PROMs. Socket U8 can be used with 8K × 8 static RAMS, 2K × 8 RAMs, 2764-type, 2732-type or 2716-type PROMs. Sockets U9 and U10 can use 2K × 8 RAMs, 2732-type or 2716-type PROMs. In addition, any socket may host a Rockwell R5213/2816 EEROM. The R65FR1 Development ROM is normally installed in U7.

The floppy disk controller (U12) is a Western Digital WD2793 device. The 74LS10 (U4) generates the $\overline{RD}$ and $\overline{WR}$ strobes while U14 and U18 buffer the input and output signals. U14 also forms a status register to allow the processor to read the FDC INT and DRQ lines. U15 forms an output latch to control the drive/side selection and the motor. A "test" jumper puts the WD2793 into the test mode for calibration.

A RS232 buffer is formed by the 1458 op-amp (U17) and a −5V supply is generated by U16. Connector J5 is configured to drive a parallel printer and J3 provides an expansion port for additional memory or I/O.

SOFTWARE CONSIDERATIONS

When the R65F11 is reset due to power up or reset, several variables assume default values which may need to be changed by the user. One of these is the top of memory pointer used by the disk interface. Reset assumes the presence of 8K of RAM from $0300–$1FFF. In the example given here, only 6K of memory is available ($0300-$17FF). In order for the disk buffers to work, the top of the memory must be set to 6K. The following commands will perform this function:

HEX 1800 MEMTOP DECIMAL [RETURN]

The R65F11 has been designed with vectored I/O so that user written I/O routines may be used as an alternative to the internal ones. The console input and output is vectored through the locations UKEY ($0044) and UEMIT ($0046) and the disk is vectored through UR/W ($30A). As an example of using these vectors, Listing 1 shows a method of patching UEMIT to direct the console output to a parallel printer port. This listing also shows a method of using the headerless code generation to create words and then forget the heads (only) of those words which will not be used again.

Listing 1. Implementing a Printer Driver

```
SCR #10
0   ( CENTRONICS DRIVER FOR RSC FORTH DEVELOPMENT
    BOARD )
1   ( FILTER OUT FORM FEEDS ) BASE @ HEX
2   LATEST DP @ 100 + H/C
3   CODE STB-PRT 10 3 RMB, 0 2 RMB, 0 2 SMB, RTS, END-CODE
4
5   CODE ACK-WT BEGIN, 11 3 BITSET UNTIL, RTS, END-CODE
6
7   CODE HOUT 1 STA, OA # CMP, O = NOT IF,  ' STB-PRT CFA
    @  JSR,
8    ' ACK-WT CFA @  JSR, THEN, RTS, END-CODE
9   0 HEADERLESS !
10  : P-ON [ ' HOUT CFA @ ] LITERAL 0046 ! ;
11
12  : P-OFF F5EF 0046 ! ;
13  : FORM-FEED OC EMIT ;
14  ' P-ON LFA ! BASE !
15  ;S
```

Table 1. Decode PROM (U6) Coding

The following configuration is assumed:

Funct	Address Space	Code	Signal	Socket
FDC	$0100–$013F	7F	FDC	U12
RAM1	$0200–$07FF	F7	MEM3	U10
RAM2	$0800–$0FFF	FB	MEM2	U9
RAM3	$1000–$17FF	FD	MEM1	U8
ROM	$2000–$3FFF	FE	MEMO	U7
Not Used	$1800–$1FFF	FF	No Chip Selected	
Page Zero	$0000–$00FF	FF	No Chip Selected	
Page One (ex FDC)	$0140–$01FF	FF	No Chip Selected	

msb/lsb	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	FF	FF	FF	FF	7F	FF	FF	FF	F7	F7	F7	F7	F7	F7	F7	F7
1	F7	F7	F7	F7	F7	F7	F7	F7	F7	F7	F7	F7	F7	F7	F7	F7
2	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB
3	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB
4	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD
5	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD	FD
6	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
7	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
8	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
9	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
A	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
B	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
C	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
D	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
E	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE
F	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

Table 2. Jumper Selection

Socket	Part Type	Jumper Position at Pin		
U7		**p27**	**p20**	
	8K × 8 RAM	R/$\overline{W}$	$\overline{RMEMO}$	
	2764 PROM	+5	$\overline{MEMO}$	
	2732 PROM	+5	$\overline{MEMO}$	
U8		**p27**	**p23**	**p20**
	8K × 8 RAM	R/$\overline{W}$	A11	$\overline{RMEM1}$
	2K × 8 RAM	R/$\overline{W}$	R/W	$\overline{RMEM1}$
	2764 PROM	+5	A11	$\overline{MEM1}$
	2732 PROM	+5	A11	$\overline{MEM1}$
	2716 PROM	+5	+5	$\overline{MEM1}$
U9		**p21**	**p18**	
	2K × 8 RAM	R/$\overline{W}$	$\overline{RMEM2}$	
	2732 PROM	A11	$\overline{MEM2}$	
	2716 PROM	+5	$\overline{MEM2}$	
U10		**p21**	**p18**	
	2K × 8 RAM	R/$\overline{W}$	$\overline{RMEM3}$	
	½ 2732 PROM	+5	$\overline{MEM3}$	
	2716 PROM	+5	$\overline{MEM3}$	

U1 R65F11

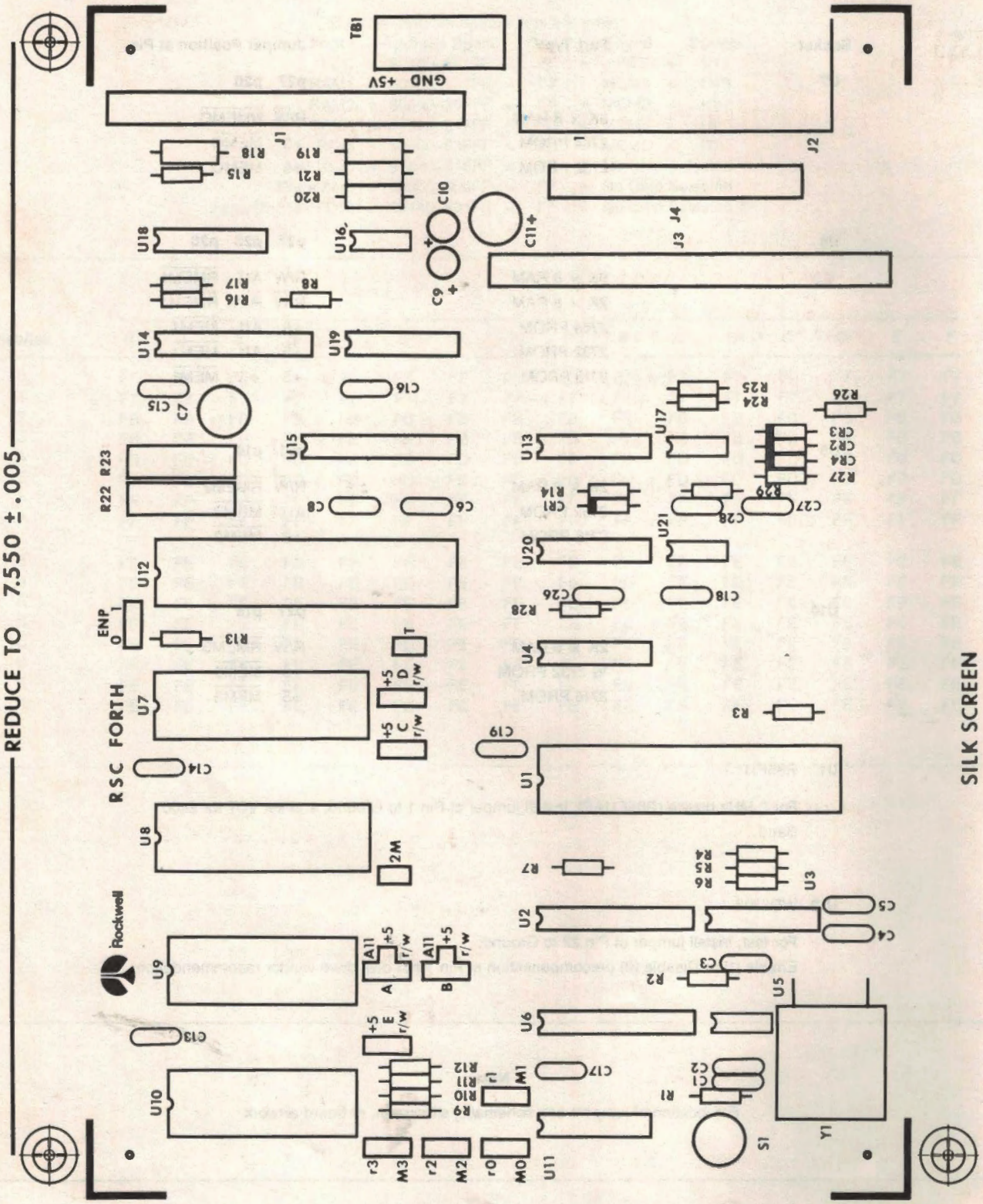
For 2 MHz device (R65F11AP), install jumper at Pin 1 to Ground; and set VDT for 2400 Baud.

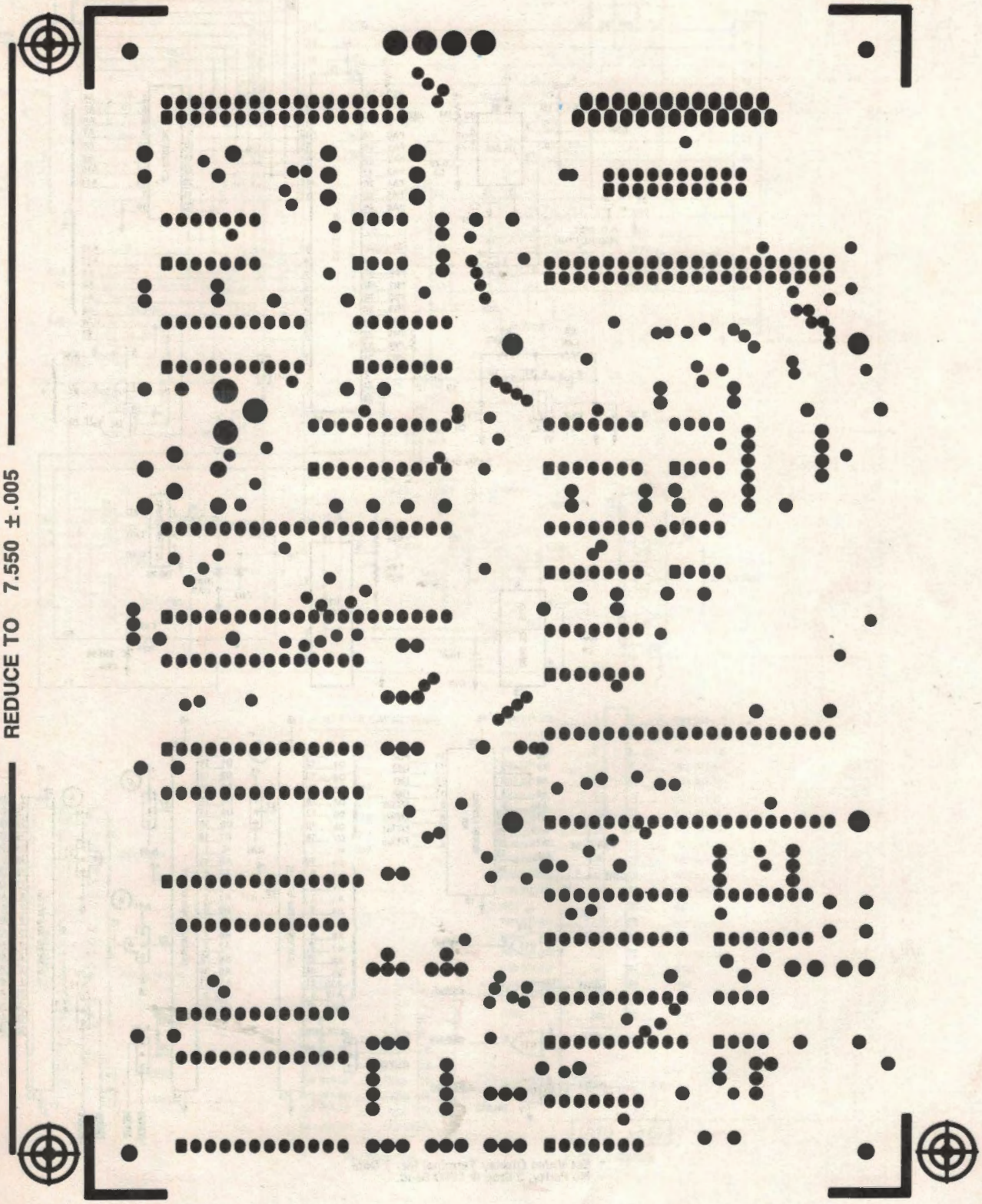
U12 WD2793

For test, install jumper at Pin 22 to Ground.
Enable (1) or Disable (0) precompensation at Pin 1 per disk drive vendor recommendation.

Note:

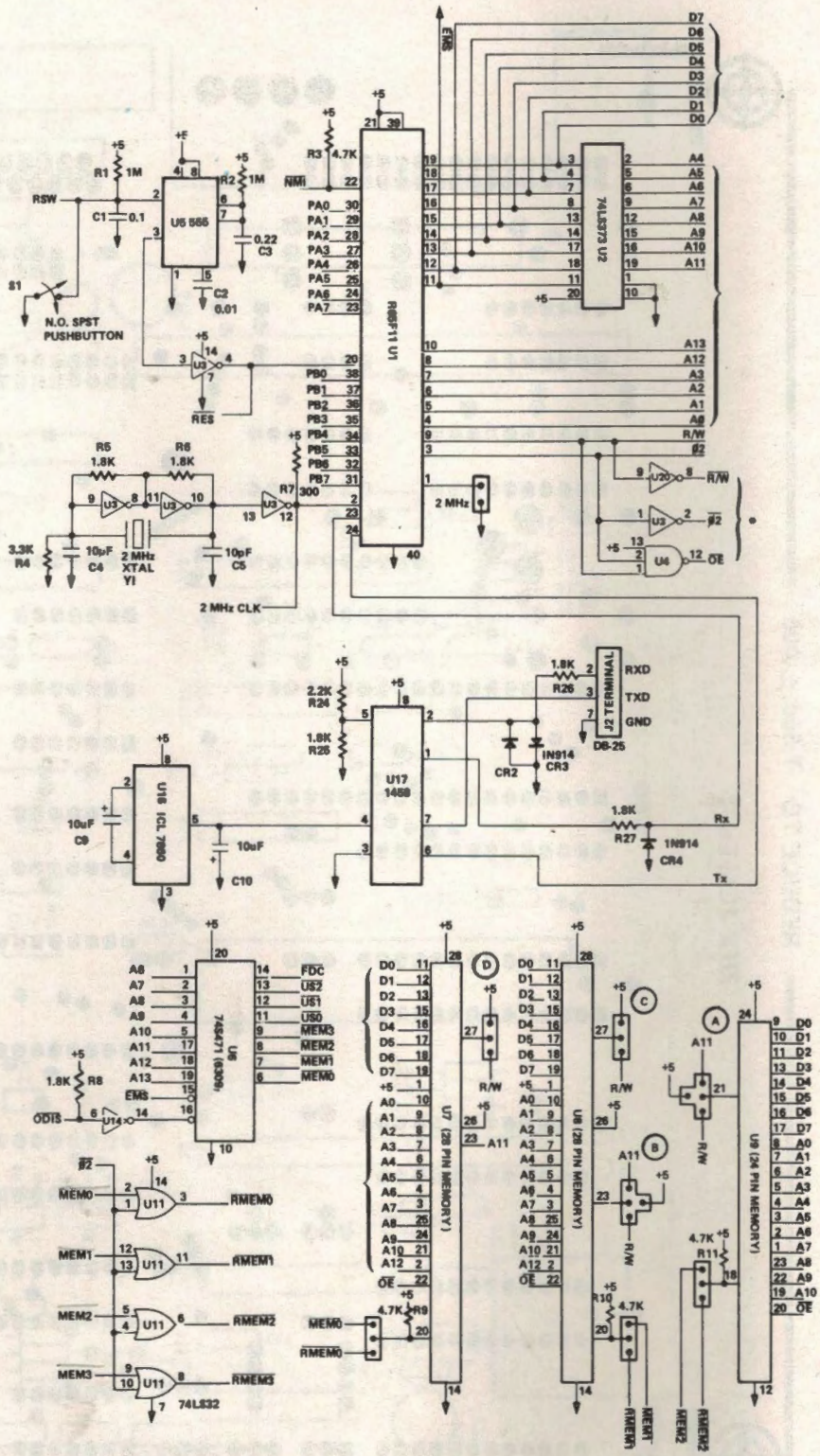
For location of jumpers see schematic, silkscreen, or board artwork.


REDUCE TO 7.550 ± .005
SILK SCREEN
TB1
GND +5V
J1
J2
J3 J4
R18
R15
R19
R21
R20
C10
C11+
C9
U18
U16
R16
R17
R8
U14
U19
C15
C7
C16
U15
R22 R23
C8
C6
U12
ENP
R13
U7
RSC FORTH
C14
U8
2M
Rockwell
U9
U10
C13
r3
M3
r2
M2
r0
M0
r1
1M
R9
R10
R11
R12
C17
U11
U13
U17
R24
R25
R26
R27
CR3
CR2
CR4
R29
C27
C28
R14
CR1
U21
U20
C26
R28
C18
U4
C19
U1
R3
U2
R7
R5
R6
U3
C5
C4
C3
R2
U5
U6
C2
C1
R1
S1
Y1

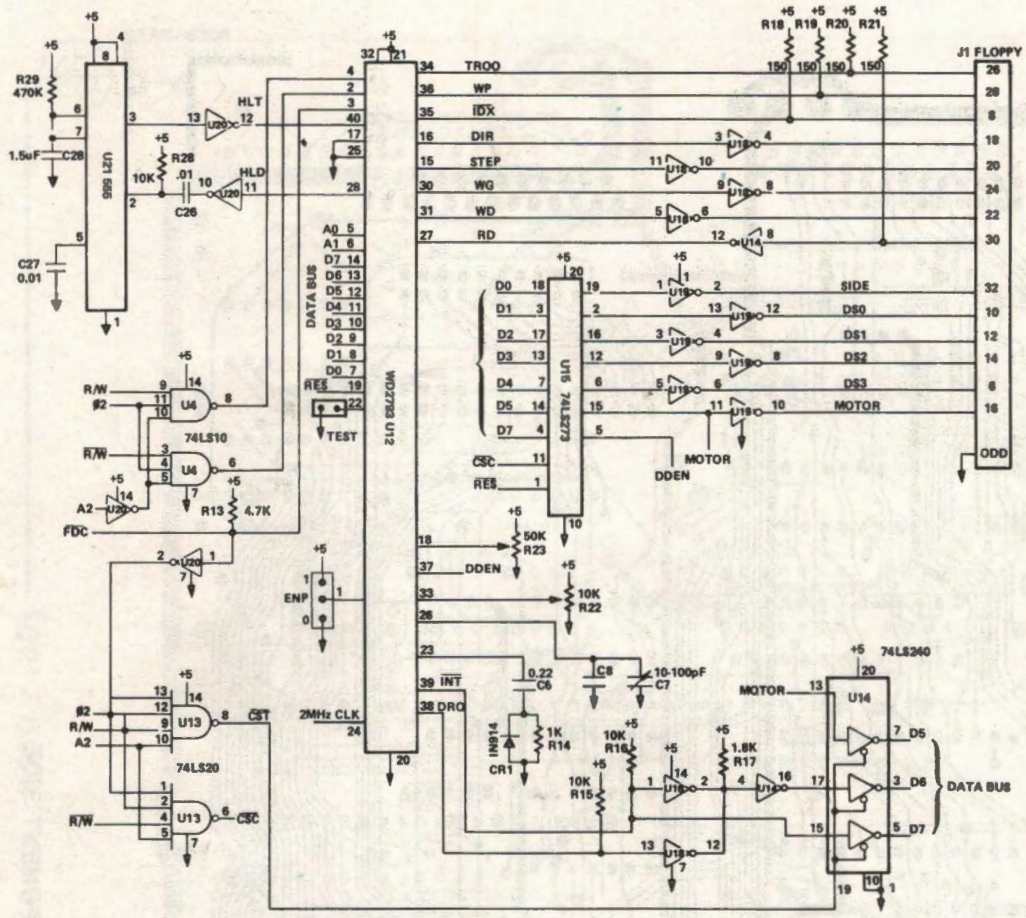


REDUCE TO 7.550 ±.005

SOLDER MASK

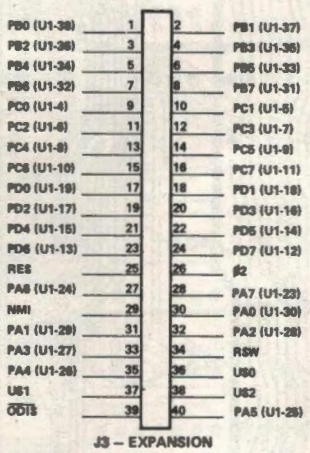


* Set Video Display Terminal for: 7 Data, No Parity, 2 Stop @ 1200 Baud.

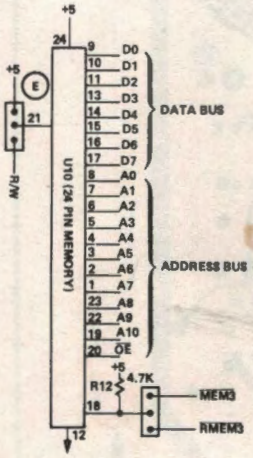


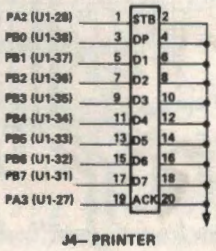
0.1 uF BYPASS CAPACITORS

C12
C13
C14
C15
C16
C17
C18

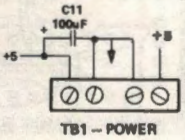


J3 – EXPANSION



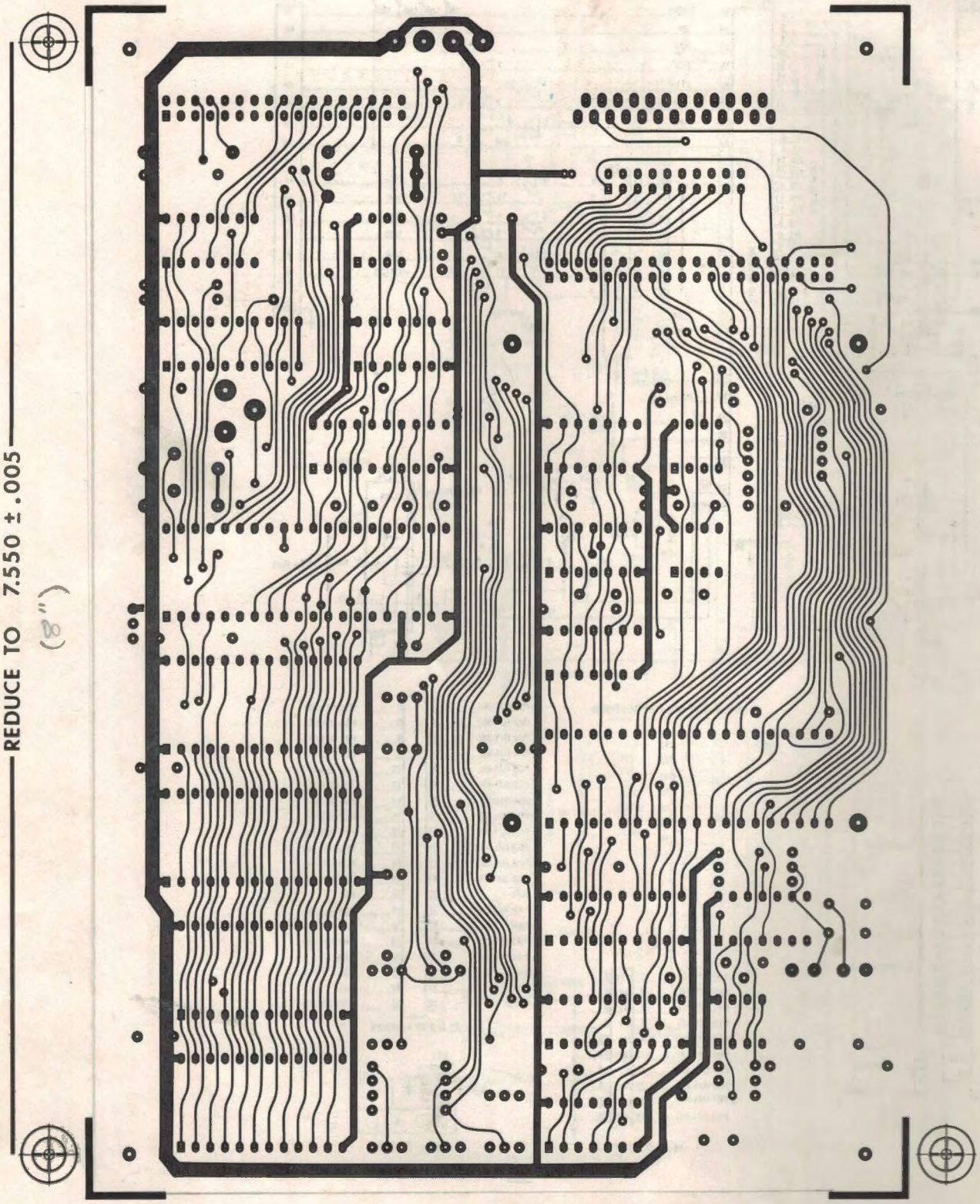


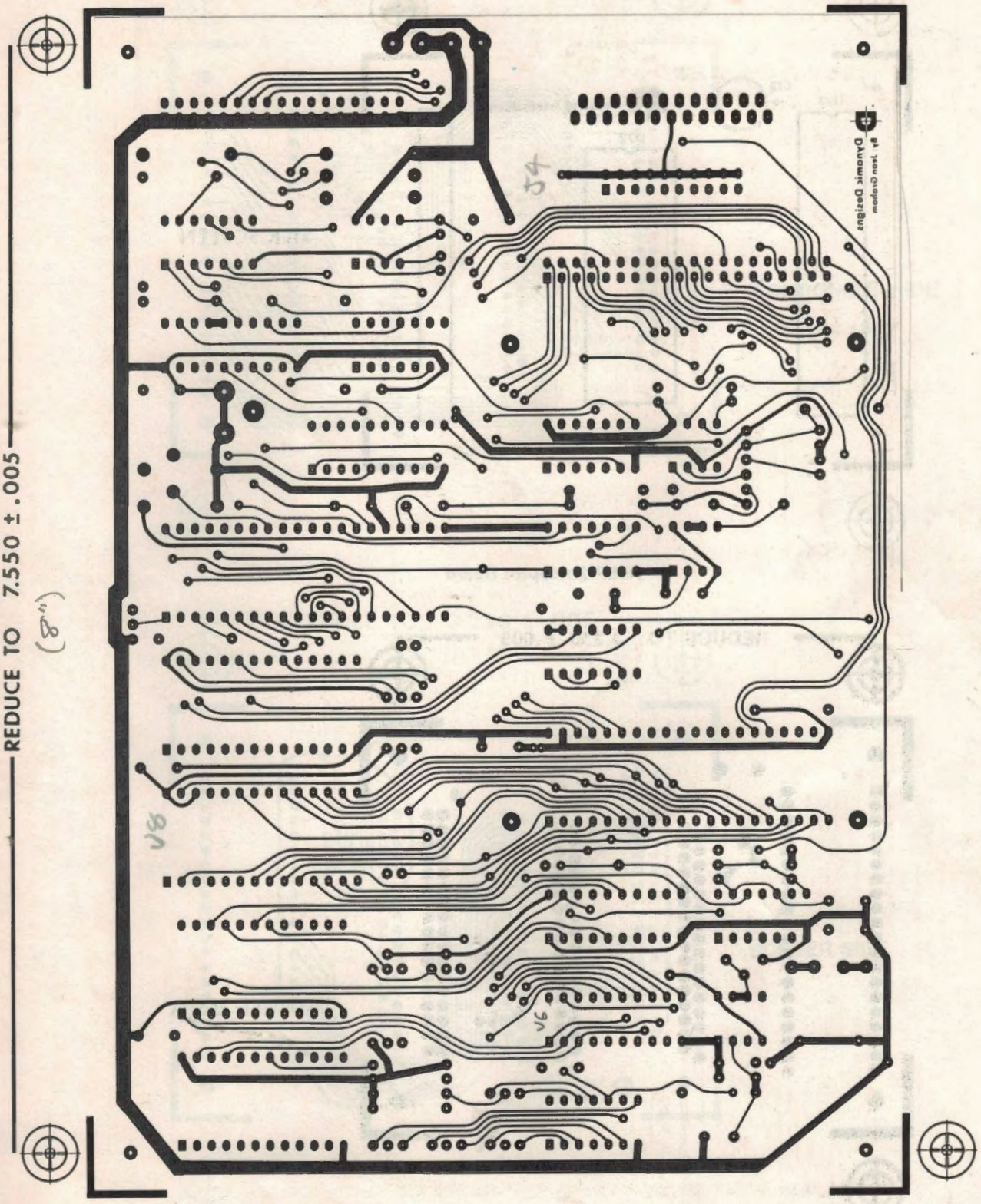
J4– PRINTER

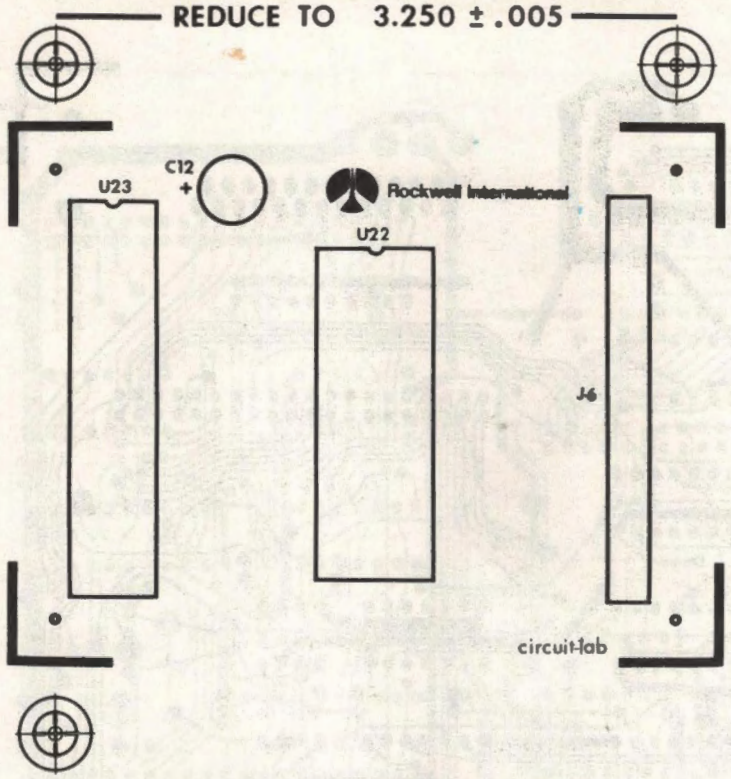


TB1 – POWER

RSC-FORTH Development System

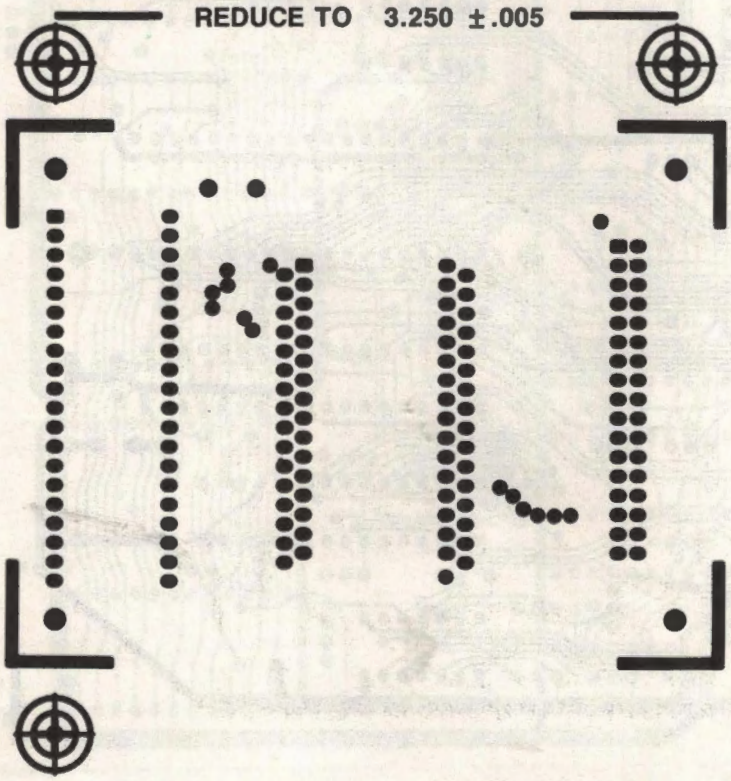

REDUCE TO 7.550 ± .005
(8")
COMPONENT SIDE


REDUCE TO 7.550 ± .005
(8")
SOLDER SIDE
(REVERSE)



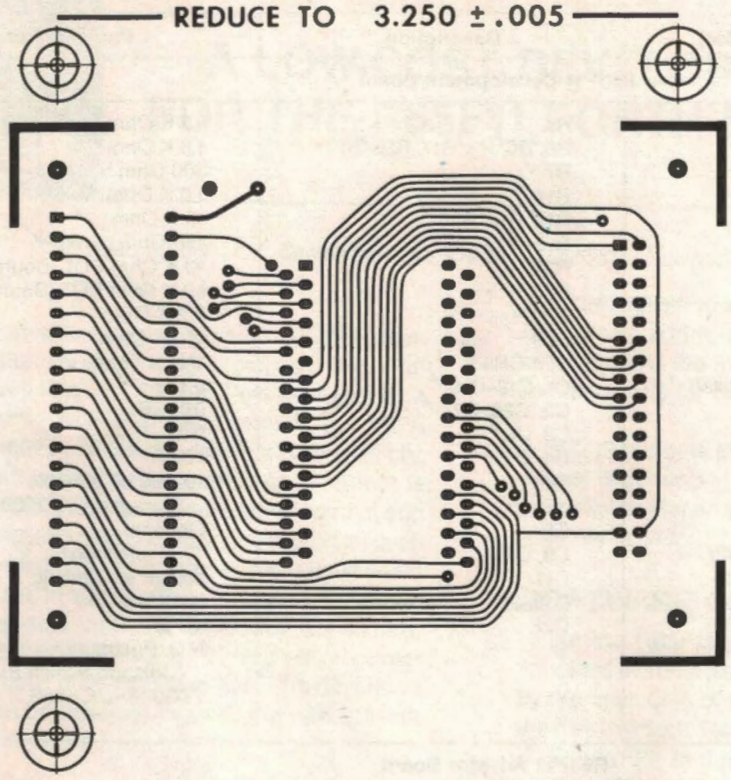
SILK SCREEN

R65F12 Adaptor Board

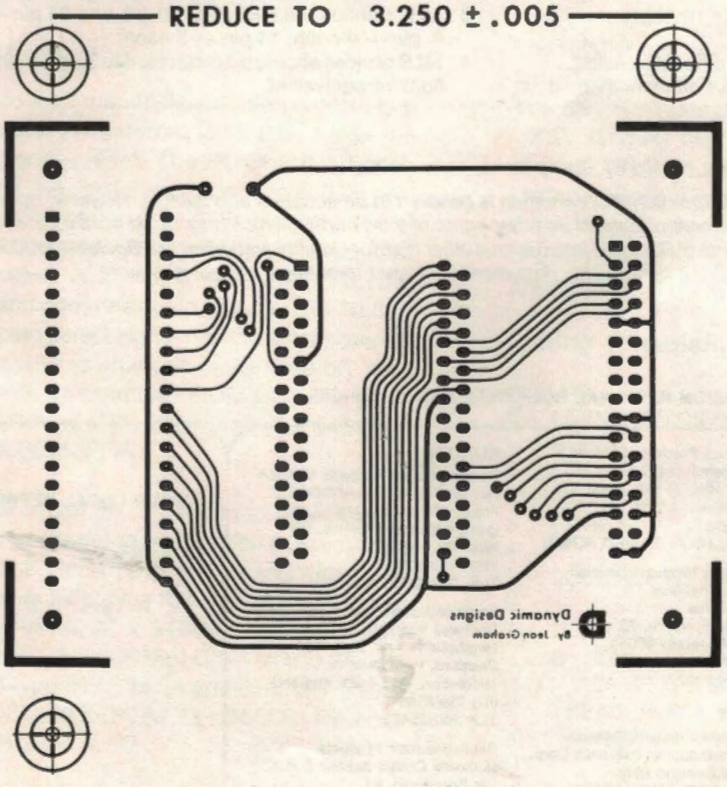


SOLDER MASK

R65F12 Adaptor Board



COMPONENT SIDE



SOLDER SIDE

Parts List

Description	Part Number (Vendor)	Description	Part Number (Vendor)
R65F11 Development Board			
U1	R65F11 (Rockwell)	R4	3.3 K Ohm
U2	74LS373 (4)	R5, R6, R8, R17, R25–R27	1.8 K Ohm
U3, U20	74LS04 (4)	R7	300 Ohm
U4	74LS10 (4)	R14	1.0 K Ohm
U5, U21	555	R15, R16, R28	10 K Ohm
U6	74S471 (6309) (4)	R18, R21	150 Ohm (½W)
U7	R65FR1 (Rockwell)	R22	10 K Ohm POT (Bourns 3009P-1-103)
U8	28-Pin Memory	R23	50 K Ohm POT (Bourns 3009-1-503)
U9	24-Pin Memory	R24	2.2 K Ohm
U10	24-Pin Memory	R29	470 K Ohm
U11	74LS32 (4)	CR1-CR4	1N914 or eq
U12	WD2793 (Western Digital)	C1, C12–C19	0.1 µF
U13	74LS20 (4)	C2, C26, C27	0.01 µF
U14	74LS240 (4)	C3, C6	0.22 µF
U15	74LS273 (4)	C4, C5	10 pF
U16	ICL7660 (Intersil)	C7	10–100 pF variable (Sprague GKF70000)
U17	LM1458		
U18, U19	7406	C8	Optional
J1	34 pin (3M #3431-2002)	C9, C10	10 µF electrolytic
J2	DB25 (AMP 2065-84-2)	C11	100 µF electrolytic
J3	40 pin (3M #3432-2002)	C19–25	Not Used
J4	20 pin (3M #3428-2002)	C28	1.5 µF
TB1	0.2″ center terminal strip (Buchanan #SSB404)	S1	N.O. Pushbutton (Chicago Switch EIA50)
R1, R2	1.0 M Ohm	Y1	2.000 MHz Crystal
R3, R9–R13	4.7 K Ohm		
R65F12 Adaptor Board			
U22	R65F12 (Rockwell)	C12	100 µF electrolytic
U23	Wire Wrap Pins (40 ea.)	J6	34 pin (3M #3431-2002)

Notes:

1. All resistors are ¼ W, 10% carbon unless otherwise noted.
2. All capacitors are 16 V ceramic disks unless otherwise noted.
3. All ICs should be socketed: 40, 28, and 24 pin — 2 each; 20 and 8 pin — 4 each; 14 pin — 7 each.
4. 74LS devices should be purchased to Texas Instruments specifications or equivalent.

Printed in U.S.A.

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