

AUROCLOCK

BY

Autogram/CRL

USER'S MANUAL

REV 1.01 AUG 12, 1985

REV. 1.02 MAY 16, 1986

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--- WARNING ---

This unit generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the user's manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of the FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this unit in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

--- WARNING ---

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1.0 INTRODUCTION

The AUTOCLOCK by AUTOGRAM provides 7 of the most useful time and temperature functions in a single console mounted unit. Through the use of two LED displays the AUTOCLOCK can keep track of and display the following:

- * TIME - battery backed, crystal controlled time provides HOURS, MINUTES, and SECONDS with PM indicator.
- * DATE - battery backed, crystal controlled date provides MONTH, DAY OF MONTH, YEAR, DAY OF WEEK with leap year corrections built in.
- * TEMPERATURE - provides temperature readings from an external probe. Displays degrees Fahrenheit (-40 to 190) and Celsius (-40 to 88).
- * TEMPERATURE HIGH OF DAY - in degrees F or C, as well as the time of day when the high temperature occurred (HH MM).
- * TEMPERATURE LOW OF DAY - in degrees F or C, as well as the time of day when the low temperature occurred (HH MM).
- * UP COUNTER - provides timings to 99.59 (MM.SS). Timer is controlled by external switches that provide RESET/START, STOP/RESET, and START/CONT functions.
- * DOWN COUNTER - provides a count down timer that is presettable from 1 to 32 seconds and triggered by an external switch. May be connected to the tertiary output of sources to trigger the timer for an end of spot countdown.

In addition to the above displayed functions the AUTOCLOCK contains an external TOP OF HOUR SYNC that allows the TIME to automatically sync itself to an external source. The source may be a network top of hour pulse or a decoded WWV top of hour pulse. While the clock is battery backed and crystal controlled the TOP OF HOUR SYNC provides the ultimate in time accuracy.

All AUTOCLOCK units have the ability to communicate over a serial link to other units. This powerful feature allows AUTOCLOCK units to be distributed throughout a station and display the same TIME, DATE, and TEMPERATURE (including HIGH and LOW of the day). The up and down counters and the ability to display temperature in F or C remains local to each unit. To create a link between several AUTOCLOCK units simply wire one AUTOCLOCK as the trans-

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mitter and the rest as receivers. Up to 10 clocks can be linked to one transmitter. Also each clock wired as a receiver can transmit to an additional 10 clocks making the number of clocks that can be synchronized unlimited. Clocks can be located up to 1000 feet from the transmitter clock.

Section 2 describes how to operate the AUROCLOCK and interpret its display modes. Section 3 describes how to install, calibrate and wire in the many options available with AUROCLOCK. Section 4 is the Theory of Operation and describes the internal circuitry.

2.0 OPERATION

This section will describe how each of the AUTOCLOCK display mode are accessed, set, and interpreted.

2.1 DISPLAY INDICATORS AND SWITCHES

The AUTOCLOCK provides two LED displays for displaying the TIME, DATE, TEMPERATURE, UP COUNTER, and DOWN COUNTER (refer to Figure 2.1). The top display is used to display TIME and DATE information. When displaying TIME the PM indicator will turn on to indicate PM. When the AUTOCLOCK is wired as a receiver and is receiving valid TIME, DATE, and TEMPERATURE information the AUTOCLOCK COMM SYNC indicator will turn on.

The bottom display is used to display TEMPERATURE, UP COUNTER, and DOWN COUNTER information. Refer to sections 2.2 through 2.6 for more information on the display modes.

2.1.1 POWER UP SEQUENCE

When the AUTOCLOCK is first powered on it will blink the seconds digits of the TIME display. This is to indicate that the seconds digits may not be correct. When the first change in minutes is detected the seconds digits will be reset to 00 and the blinking will stop.

2.1.2 BATTERY FAILURE

The AUTOCLOCK will blink all the digits of the TIME display if it has detected a battery failure while powered off. The display will continue to blink until the TIME has been reset. When this occurs replace the battery.

If the battery fails while the AUTOCLOCK is powered on the TIME and DATE displays will display blinking dashes (-- -- --) to indicate a failed battery. When this occurs replace the battery.

2.1.3 TOP OF HOUR SYNC INDICATOR

When the AUTOCLOCK senses a TOP OF HOUR SYNC signal it will turn on the TOP OF HOUR SYNC INDICATOR. This indicator will turn on even if the signal is detected outside the +/- 5 second top of hour window (refer to section 3.5).

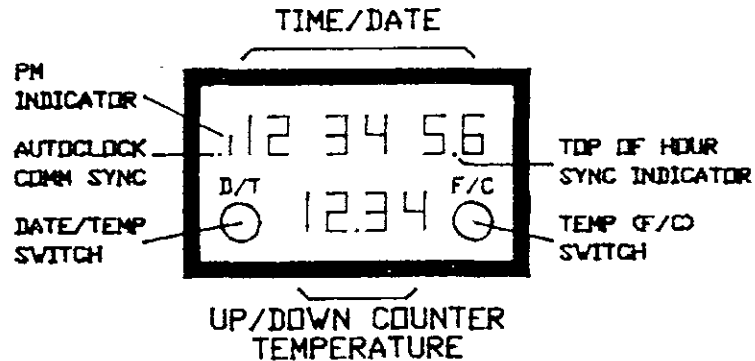


Figure 2.1

2.2 TIME/UP COUNTER

Normally the AUTOCLOCK will be in this mode (refer to Figure 2.2). The top display will display TIME and the bottom display will display the UP COUNTER. Three of the external switches are used to control the UP COUNTER.

The RESET/START switch is used to reset the UP COUNTER to 0.00 and start it counting. The prime use of this input is to reset and start the UP COUNTER everytime a new source is started from one of the START switches on the console. The console START switches should be wired in parallel so that any one of the switches will reset/start the UP COUNTER.

The STOP/RESET switch is used to stop the UP COUNTER at its current time. If the timer is already stopped then pressing the STOP/RESET switch a second time will cause the timer to reset to 0.00.

The START/CONT switch is used to restart or continue the UP COUNTER timer. The START/CONT switch and the STOP/RESET switch can be used in a production environment to provide an accumulative timer.

The UP COUNTER timer will count to 99.59 then reset and continue at 0.00.

2.2.1 SETTING THE TIME

The TIME is set as follows:

- 1 - With the TIME being displayed on the top display, press the SET switch (located on the back of the AUTOCLOCK unit). The HOUR digits will start to blink.
- 2 - Advance the HOUR digits to the correct hour by pressing the D/T switch on the front of the clock (holding the D/T switch in will cause the digits to increment automatically).
- 3 - After the HOUR has been set, press the SET switch again. The MINUTE digits will start to blink.
- 4 - Advance the MINUTE digits using the D/T switch.
- 5 - After the MINUTES have been set, press the SET switch again. The SECOND digits will blink.
- 6 - Advance the SECOND digits using the D/T switch.
- 7 - Pressing the SET switch one more time will complete the TIME set procedure.

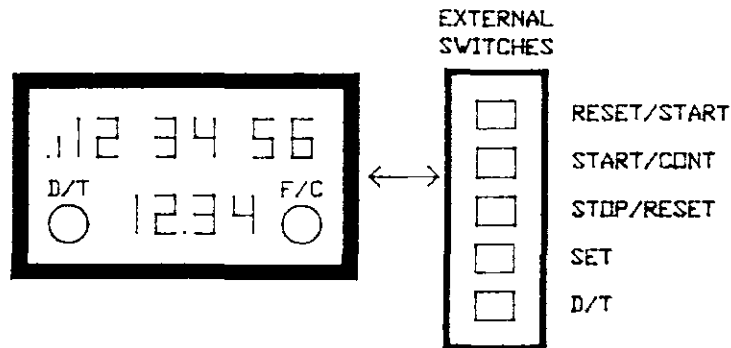


Figure 2.2

2.3 DATE

When the TIME is being displayed (Figure 2.2), pressing the D/T (Date/Temperature) switch will cause the DATE to be displayed (refer to Figure 2.3). The DATE will be displayed while the D/T switch is pressed and held. After the D/T switch is released the DATE will continue to be displayed for another two seconds, or until the D/T switch is pressed again. The AUTOCLOCK will then redisplay the TIME.

2.3.1 SETTING THE DATE

The DATE is set as follows:

- 1 - With the DATE being displayed on the top display (after the D/T switch has been pressed), press the SET switch (located on the back of the AUTOCLOCK unit). The MONTH digits will start to blink.
- 2 - Advance the MONTH digits to the correct month by pressing the D/T switch on the front of the clock (holding the D/T switch in will cause the digits to increment automatically).
- 3 - After the MONTH has been set, press the SET switch again. The YEAR digits will start to blink.
- 4 - Advance the YEAR digits using the D/T switch.
- 5 - After the YEAR has been set, press the SET switch again. The DAY OF MONTH digits will blink.
- 6 - Advance the DAY OF MONTH digits using the D/T switch.
- 7 - After the DAY OF MONTH has been set, press the SET switch again. The DAY OF WEEK digit will blink.
- 8 - Advance the DAY OF WEEK digit using the D/T switch. (1=Sun, 2=Mon, ... 7=Sat)
- 9 - Pressing the SET switch one more time will complete the DATE set procedure.

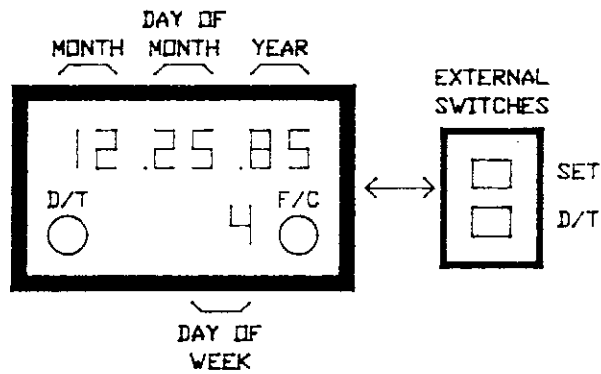


Figure 2.3

2.4 TIME/TEMPERATURE

Pressing the F/C (Fahrenheit/Celsius) switch will allow the AUROCLOCK to display TEMPERATURE (refer to Figure 2.4). The TEMPERATURE can be displayed either in degrees Fahrenheit or degrees Celsius. To toggle between Fahrenheit and Celsius simply press and hold the F/C switch then press the D/T switch one time. The last selected temperature scale (F or C) is remembered and will be used as the new default.

Refer to Section 3.3.1 on calibrating the temperature probe.

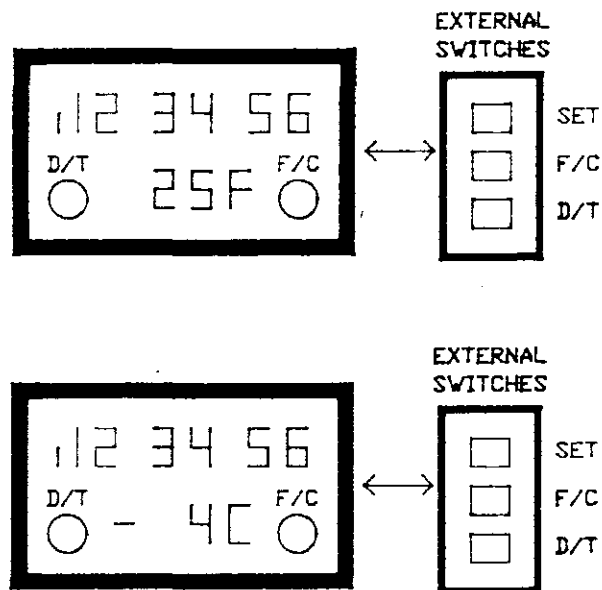


Figure 2.4

2.5 TEMPERATURE HIGH/LOW

To the display the HIGH and LOW temperature of the day simply press and release the F/C switch to display the current temperature. Then press the D/T switch to toggle between the HIGH/LOW/CURRENT temperatures (refer to FIGURE 2.5). The time the HIGH/LOW temperature was set will be displayed on the top display in HH MM format. The AUTOCLOCK will reset then HIGH/LOW temperature at 12:00:00 PM.

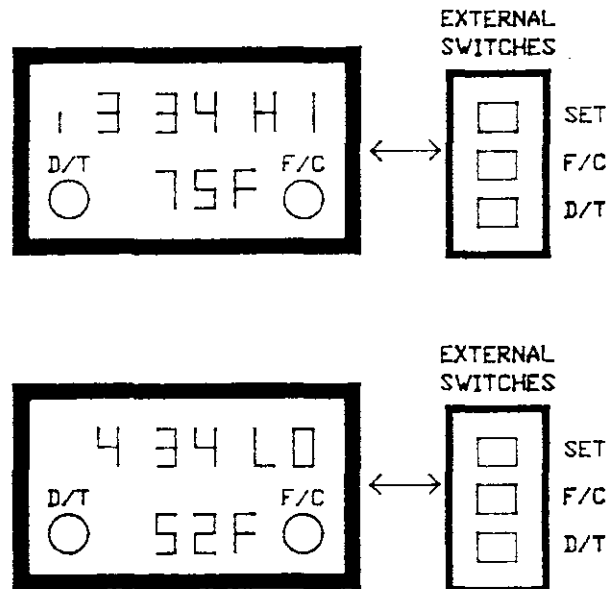


Figure 2.5

2.6 TIME/DOWN COUNTER

Whenever the DOWN COUNTER is counting it will be displayed on the bottom display (except when displaying DATE or TEMPERATURE). The DOWN COUNTER is activated by pressing both the START/CONT and the STOP/RESET switches together (refer to Figure 2.6). See section 3.2 for wiring in a separate DOWN COUNT switch or relay.

Refer to Section 3.3.1 on setting the DOWN COUNTER time.

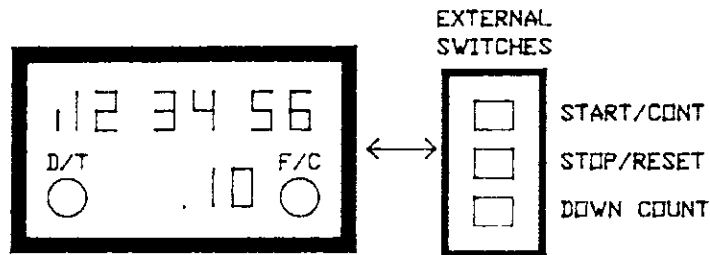


Figure 2.6

2.7 DISPLAY AUROCLOCK VERSION NUMBER

The version number of the AUROCLOCK board can be displayed as follows:

- 1 - Press and hold the T/D switch.
- 2 - Press and hold the F/C switch.
- 3 - Press and hold the SET switch on the back of the clock.

The version number will be displayed on the bottom display in the form of X.XX (ex. 1.02).

3.0 INSTALLATION

This section will describe the installation of the AUROCLOCK into one of AUTOGRAM'S audio consoles (AC-6, AC-8, IC-10 or LC-10).

3.1 INSTALL AUROCLOCK IN AUTOGRAM CONSOLES

The AUROCLOCK is designed to be installed to the right of the front panel meters in all AUTOGRAM consoles. Refer to Figure 3.1 and 3.3 for the following installation steps.

- 1 Remove the top plate and the DISPLAY ASSEMBLY from the AUROCLOCK chassis.
- 2 If the AUROCLOCK is being installed in an AC-6 or AC-8, install the two display spacers over the studs on the back of the console's front panel.
- 3 Install the clock chassis over the studs and secure with lock washers and nuts.
- 4 Slide the AUROCLOCK uC board into the chassis through the two card edge guides to the connector on the back of the chassis (component side up).
- 5 Connect the regulator cable to J4, the battery cable to J3, and the SET switch cable to J2-2 (Figure 3.4).
- 6 Install the DISPLAY ASSEMBLY through the front of the console and connect the 20 pin display connector the the right angle connector on the uC board.
NOTE: The D/T and F/C switch cables must be routed up and around the 20 pin connectors.
- 7 The DISPLAY ASSEMBLY should be pushed flush with the front of the console. The 20 pin connectors provide sufficient pressure to hold the assembly in place.
- 8 Connect the D/T cable to J2-3 and the F/C cable to J2-1 (Figure 3.3).

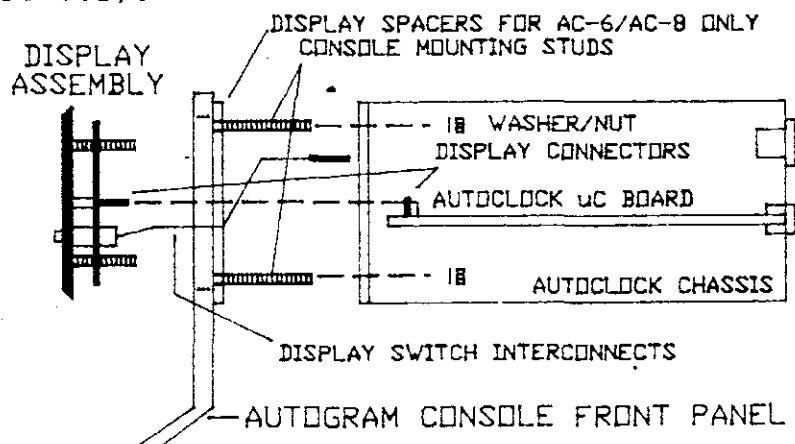


Figure 3.1

Before installing the top back on the AUTOCLOCK chassis insert a AAA battery into the battery holder on the right of the chassis (Figure 3.3) with the positive end towards the display assembly and review sections 3.2 and 3.3.

3.2 EXTERNAL WIRING

With the AUTOCLOCK installed in the console the back connector can now be wired. If the clock is being installed in an AUTOGRAM console some of the wiring may already be in place. Refer to Figure 3.2A for the identification of existing console wiring.

All wiring to the clock goes to the 30 pin connector on the back of the clock chassis. Figure 3.2 and Table 3.2 show the connector pin numbering. The top row of connectors are labeled A-S and are all connected to the circuit ground. The bottom row of connectors are labeled 1-15 and are the power, switch, communication, and temperature probe signals.

Power is provided by the wall mount power supply. It's two wires are soldered to pins A (BLK) and 1 (BLK/WHT).

All external switches are wired between the signal pins (3-9) and the accompanying ground pins (C-K). Two switches are wired as a combination of two signals. The DOWN COUNT switch is a combination of the START/CONT and STOP/RESET switch signals. The microcomputer will look for the simultaneous closure of both these switch signals for a DOWN COUNT set function to take place. The TOP OF HOUR SYNC switch (or relay) is a combination of the SET and F/C switch signals. The microcomputer will look for the simultaneous closure of both these switch signals for a TOP OF HOUR SYNC function to take place. The simultaneous closure of two switch signals can be wired in two ways (Figure 3.2B). The first way is to simply use a DPST switch while the second circuit uses a SPST switch and two signal diodes.

The temperature probe is connected between pins 14 (red wire) and 15 (black wire). Since the temperature probe is not effected by wire length additional wire (use twisted pair) may be added.

See section 3.4 for connecting several AUTOCLOCKS through the remote communications port.

AUTOCLOCK BACK

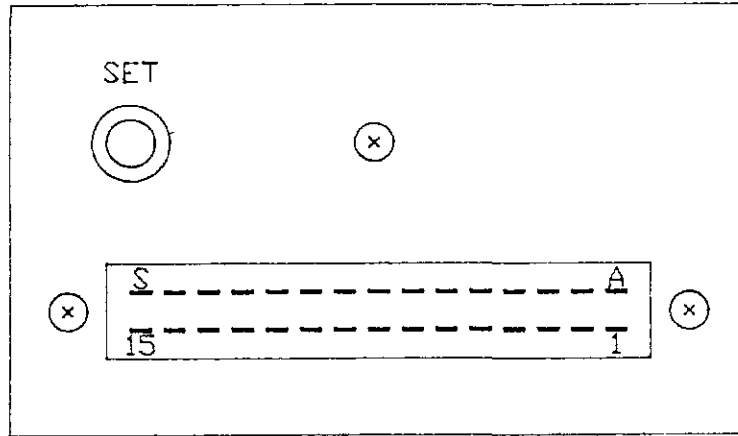


Figure 3.2

PIN #	SIGNAL NAME	PIN #	SIGNAL NAME	DESCRIPTION
TOP A	GND	BOTTOM 1	+9V	POWER IN
B	GND	2		
C	GND	3	RESET/START	EXT SWITCH
D	GND	4	START/CONT	EXT SWITCH
E	GND	5	STOP/RESET	EXT SWITCH
F	GND	6	N.U.	
H	GND	7	D/T	EXT SWITCH
J	GND	8	SET	EXT SWITCH
K	GND	9	F/C	EXT SWITCH
L	GND	10	ACXMT-	COMM XMIT
M	GND	11	ACXMT	COMM XMIT
N	GND	12	ACRCV	COMM RCV
P	GND	13	ACRCV-	COMM RCV
R	GND	14	TEMP+	TEMP PROBE
S	GND	15	TEMP-	TEMP PROBE

TABLE 3.2

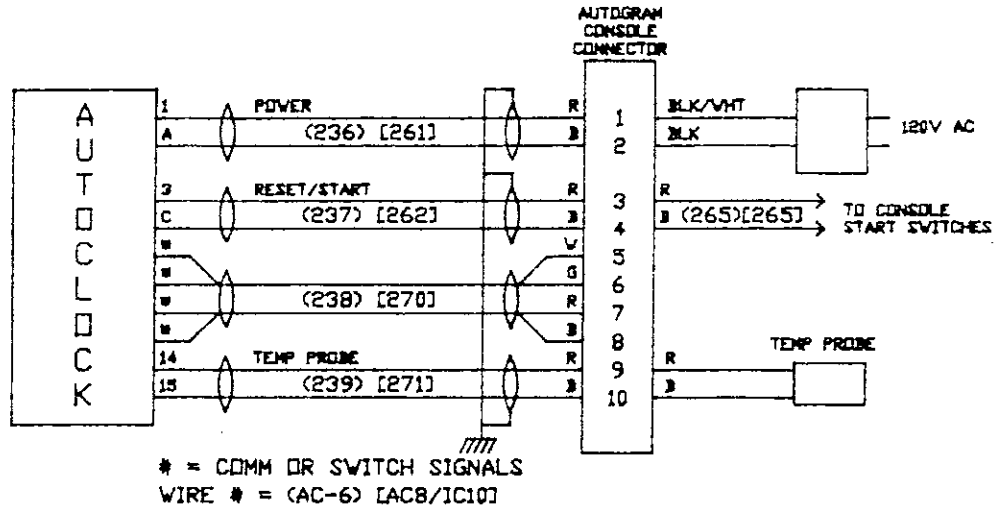


Figure 3.2A

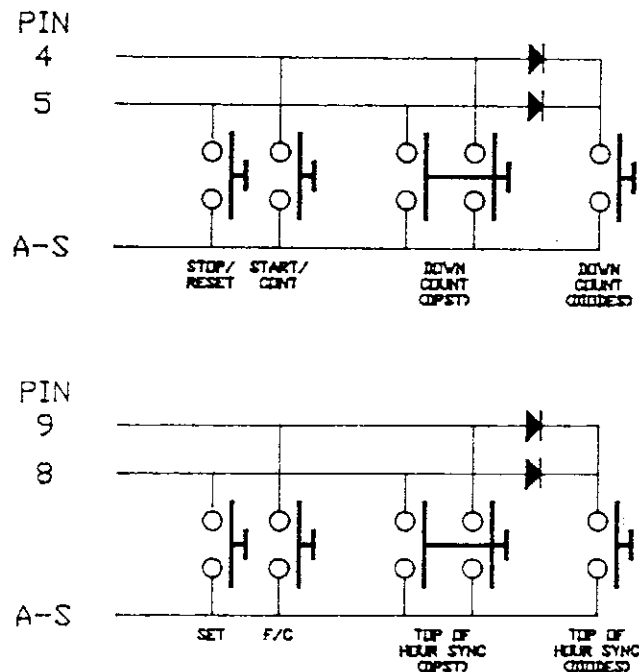


Figure 3.2B

3.3 CALIBRATING TEMPERATURE/DOWN COUNTER

There are three trimmer pots and one variable capacitor on the AUTOCLOCK uC board. These are used to set time base (C11), internal voltage reference (RP2), temperature (RP3), and DOWN COUNT time (RP1). The time base (C11) and voltage reference (RP2) are set at the factory and SHOULD NOT BE ADJUSTED. Their adjustment is described here only for information.

The real-time clock chip U5 has a 32,768 crystal to provide an accurate TIME and DATE time base. C11 is used as the final adjustment for the crystal circuit. To adjust C11 first connect a frequency counter to pin 11 (GND on pin 8) and adjust C11 to obtain a reading of 128.0000 Hz. Generally a clock-wise turn of just 1 or 2 degrees will increase the time base frequency by 1 to 2 sec/week.

The internal voltage reference VCAL is set by the trimmer pot RP2. To set VCAL connect a voltmeter between pin 11 (GND) and pin 1 (VCAL) of U3. Adjust RP2 for VCAL = 3.8528V.

3.3.1 TEMPERATURE ADJUST

To set the temperature being read by the AUTOCLOCK measure the temperature at the probe's location and adjust RP3 for the proper readout. Press and release F/C switch to display the present temperature reading, and then press and hold then SET switch on the back of the clock to disable the internal temperature filter. **IMPORTANT:** The SET switch MUST be pressed while adjusting RP3.

3.3.2 DOWN COUNT ADJUST

To set the DOWN COUNT timer, press the DOWN COUNT switch to start the down counter. While the counter is counting down, press and hold the SET switch while adjusting RP1. Pressing the SET switch will cause the down count start time to be constantly displayed and allow proper adjustment of RP1. To obtain repeatability in the DOWN COUNT timer determine where the setting of RP1 results in the next highest and lowest time and then adjust RP1 between these two settings.

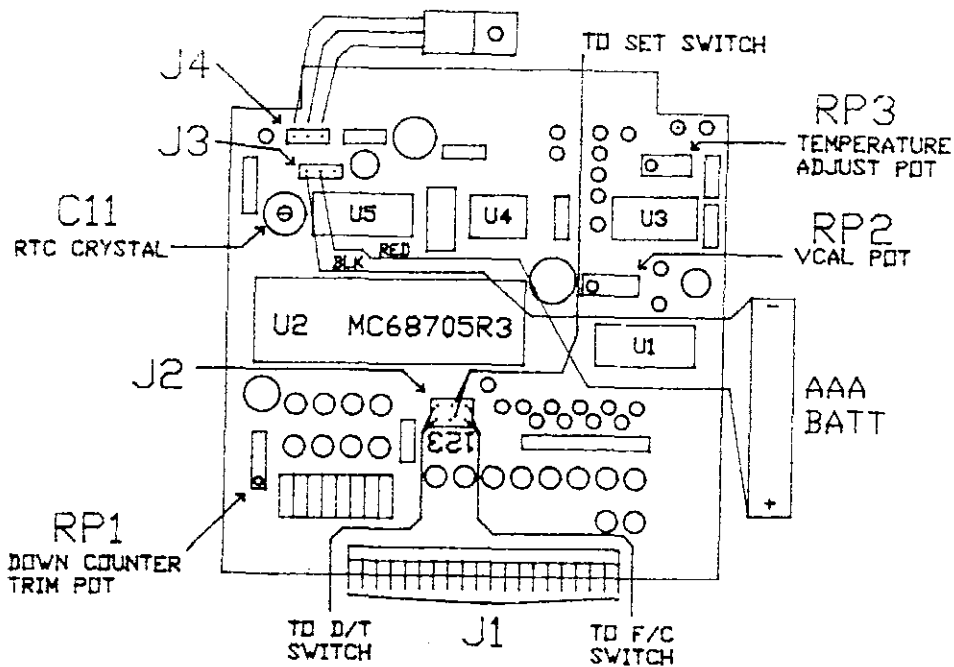


Figure 3.3

3.4 REMOTE COMMUNICATIONS WIRING

The AUTOCLOCK has the capability of connecting several clocks in a network and allowing them to sync on the same TIME, DATE, and TEMPERATURE. To allow this, each AUTOCLOCK has both a transmitter port and a receiver port, allowing each to serve as either a master or receiver. Each master can drive only 10 receivers; however, since each clock can function as both a receiver and a transmitter each receiver clock can drive an additional 10 clocks. This allows the connecting of more than 10 clocks throught a building (Figure 3.4).

To link any two clocks together simply connect their communication ports as follows:

MASTER CLOCK		RECEIVER CLOCK

PIN 11 (ACXMT)	TO	PIN 12 (ACRCV)
PIN 10 (ACXMT-)	TO	PIN 13 (ACRCV-)
PIN M (GND)	TO	PIN N (GND)

AUTOCLOCK COMMUNICATIONS NETWORK

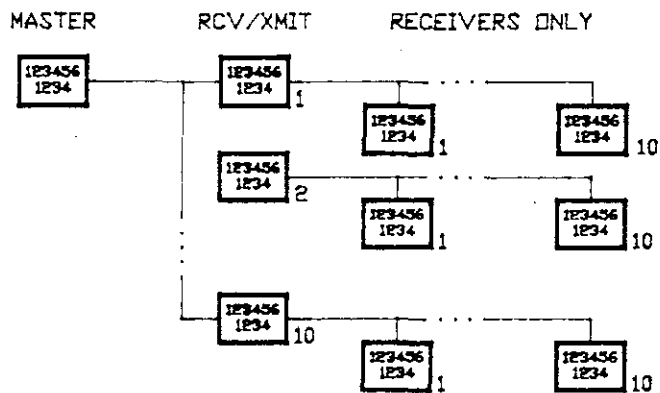
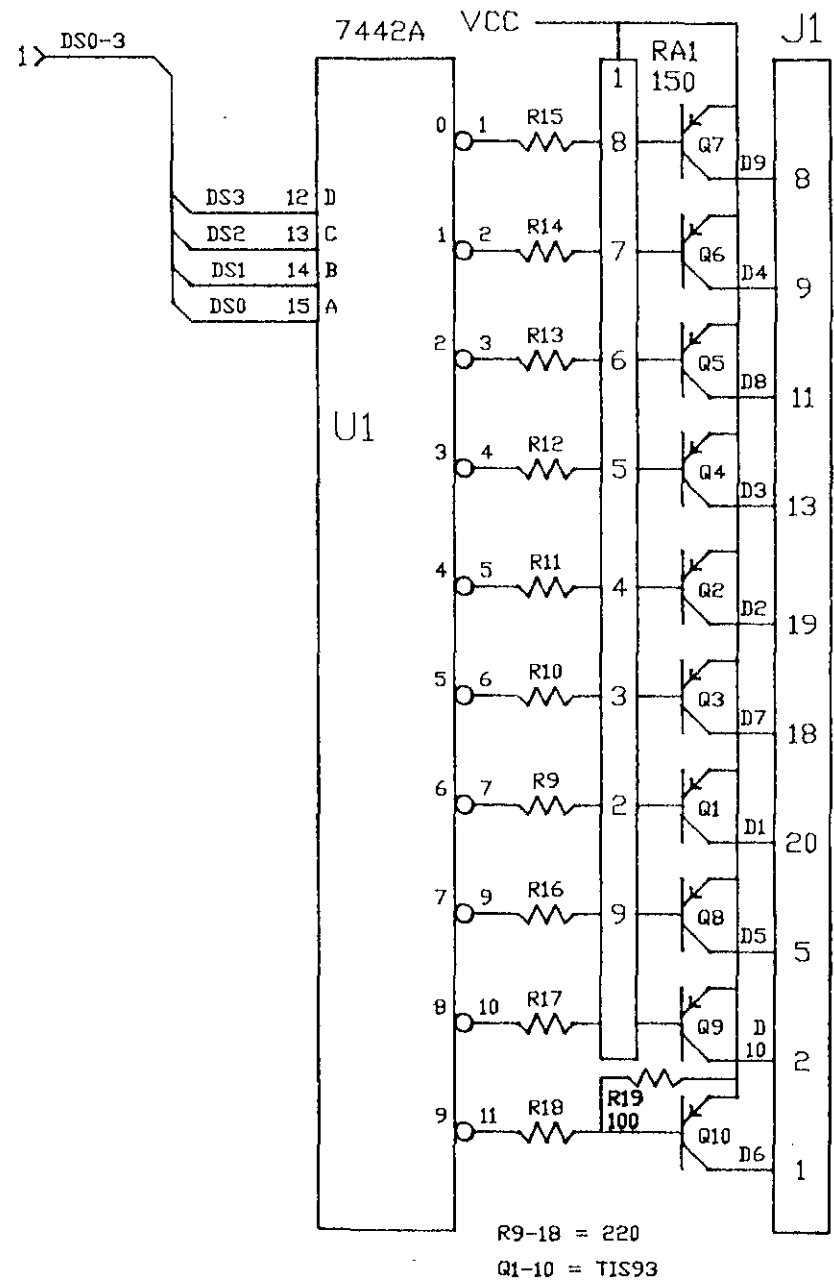
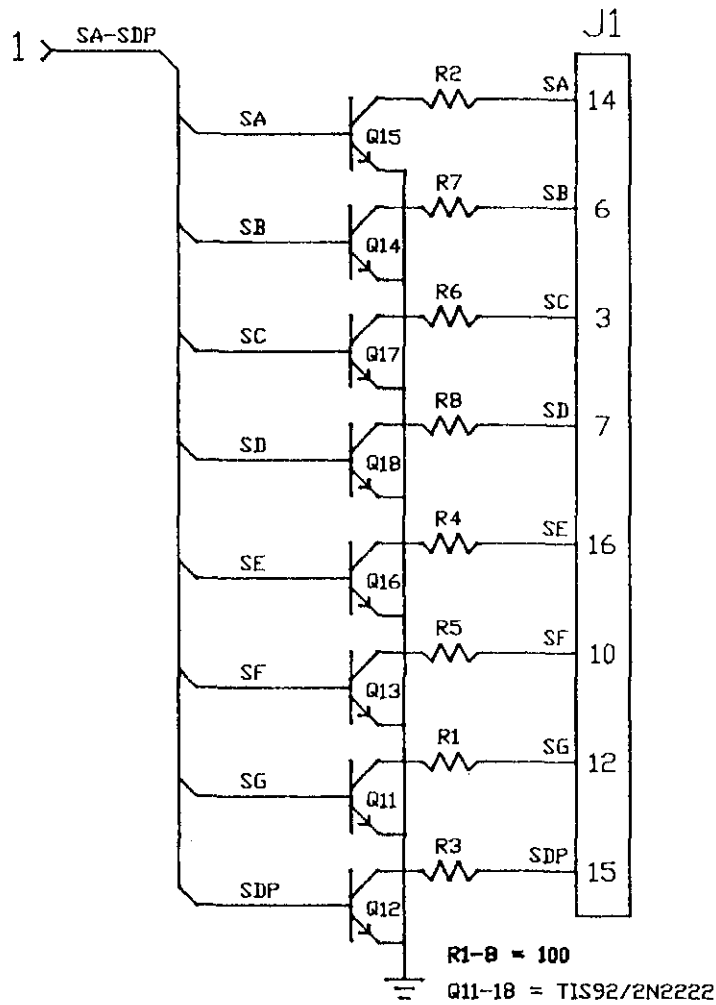


Figure 3.4



3.5 EXTERNAL SYNC WIRING

The external TOP OF HOUR SYNC input allows an AUTOCLOCK to be updated once each hour. The updating source may be a decoded WWV signal or a network top of hour feed. Refer to Figure 3.2B for ways of wiring this signal into the clock.

The AUTOCLOCK will accept a TOP OF HOUR SYNC only when it is within +/- 5 seconds of the top of the hour. This prevents accidental setting due to noise or power failure of sync source. The AUTOCLOCK triggers on the leading edge of a contact closure. The closure should be a minimum of .1 sec in duration (there is no maximum required).

4.0 THEORY OF OPERATION

This section covers the design of the internal AUTOCLOCK circuitry (Refer to Figure 4.0 and APPENDIX A).

The intelligence for the AUTOCLOCK is contained on the single chip computer (or microcomputer) U2. This chip is programmed to drive the LED display, scan the switches, read the TIME/DATE information, read and convert the temperature information, control both the UP COUNTER and the DOWN COUNTER, and handle the communication links.

The TIME and DATE information is stored on the real time clock chip U5. This chip is battery backed and has a separate crystal for use as its timebase. The microcomputer will read the TIME and DATE periodically from this chip to update its own timers.

The display is scanned by 18 transistors (10 as digit drivers and 8 as segment drivers). The segment drivers are driven directly from the microcomputer, while the digit drivers are driven by the decoder chip U1.

The temperature probe is a constant current device that has a $1\mu\text{A}/\text{degree Celsius}$ current/temperature ratio. The current is converted to a voltage by the op amp chip U3. This voltage is read by the microcomputer and converted to the proper temperature (F/C).

The communication link is controlled by the microcomputer and buffered by U3 (receiver) and U4 (transmitter).

The microcomputer scans all switches for the detection of a switch transition. All switch inputs are pulled to 5V through a 10K resistor. All switch debouncing is provided by the internal microcomputer program.

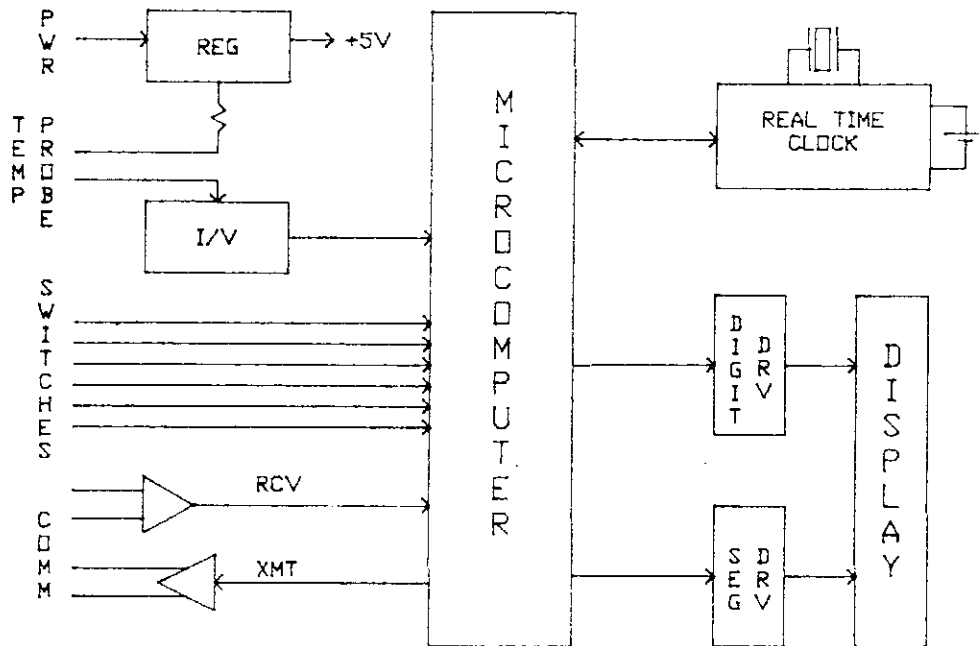


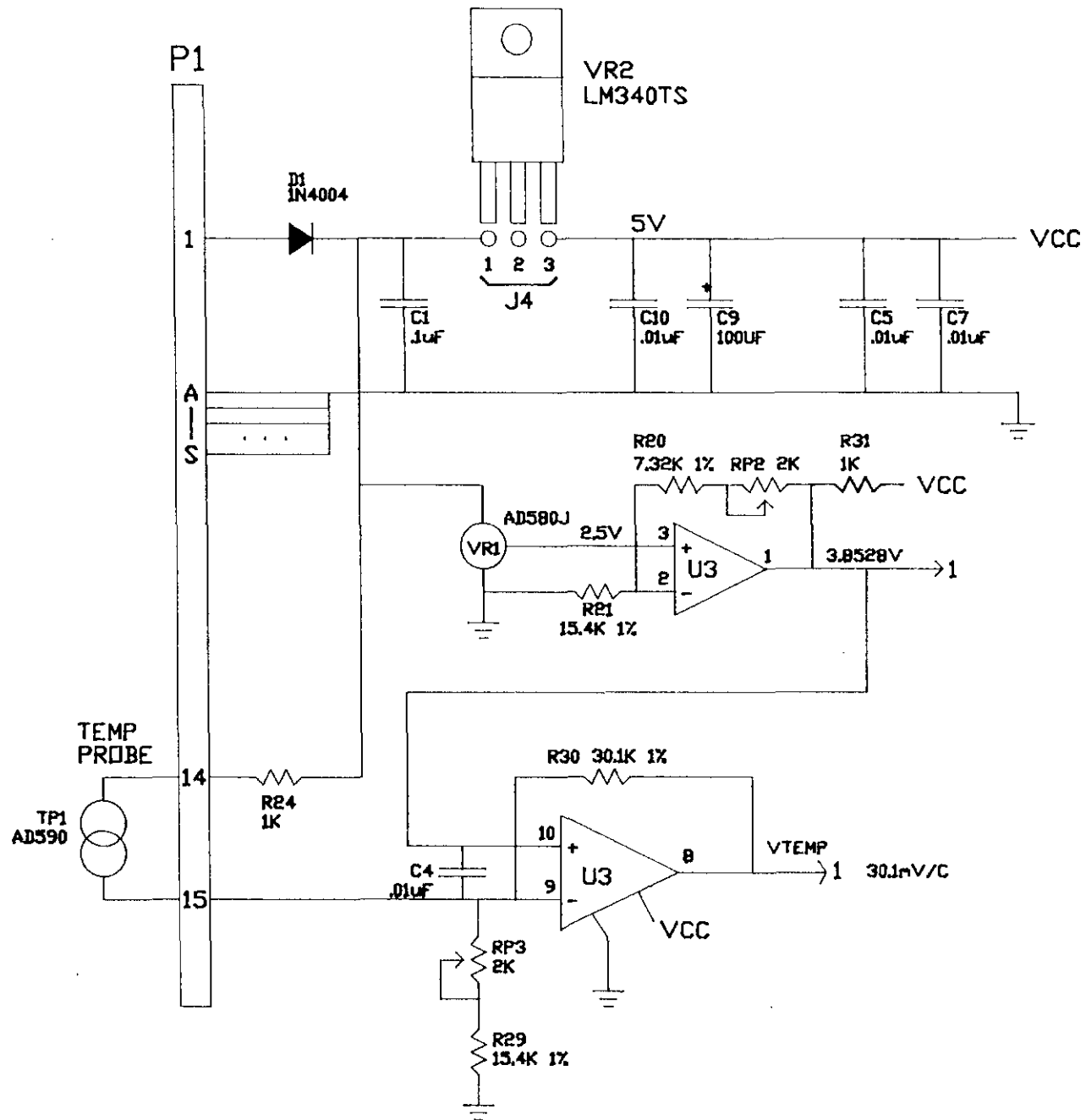
Figure 4.0

APPENDIX A - PARTS LIST/SCHEMATIC

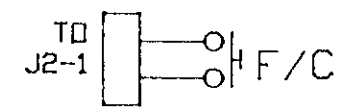
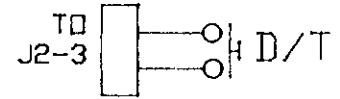
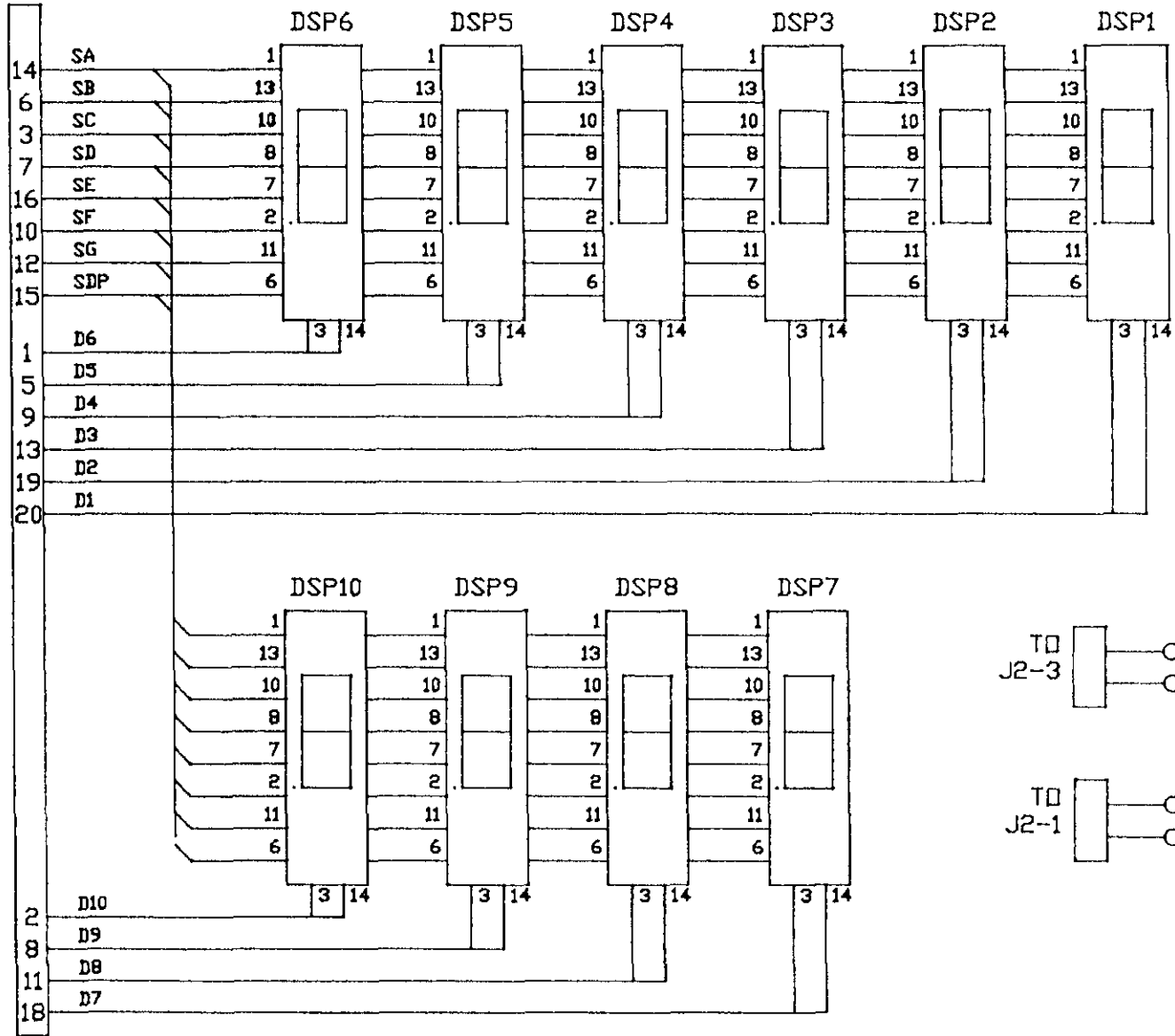
QTY	PART NUMBER	DESIGNATOR	DESCRITPION
1		C1	Capacitor, 0.1uf, 50V
5		C2,C4,C5,C7, C10	Capacitor, 0.01uf, 50V
2		C3,C9	Capacitor, 100uf, 10V, Elect.
1		C6	Capacitor, 1uf, 10V, Elect.
1		C8	Capacitor, 24pf, 50V, Mica.
1		C11	Capacitor, 3-15pf, VAR.
1		D1	Diode, 1N4004
10		DSP1-DSP10	Display, LED, HP 5082-7610
1		J1	Conn. 1 X 20, RA. .1, Male
1		J2	Conn. 2 X 3, ST. .1, Male
2		J3,J4	Conn. 1 X 3, ST. .1, Male
1		P1	Conn. 1 X 20, ST. .1, Female
10		Q1-Q10	Transistor, PNP, TIS93
8		Q11-Q18	Transistor, NPN, TIS92/2N2222
9		R1-R8,R19,R22	Resistor, 100, 1/4W, 5%
10		R9-R18	Resistor, 220, 1/4W, 5%
1		R20	Resistor, 7.32K, 1/4W, 1%
2		R21,R29	Resistor, 15.4K, 1/4W, 1%
4		R23-R25,R27, R31	Resistor, 1K, 1/4W, 5%
2		R26,R28	Resistor, 2K, 1/4W, 5%
1		R30	Resistor, 30.1K, 1/4W, 1%
1		RA1	Resistor Array, 150, SIP(10)
1		RA2	Resistor Array, 10K, SIP(10)
3		RP1-RP3	Resistor Pot, 2K, 10 turn
3		SW1-SW3	Switch, Push button
1		VR1	Regulator, 2.5V, AD580JH
1		VR2	Regulator, 5V, LM340TS
1		U1	IC, TTL, SN7442A
1		U2	IC, uC, MC68705R3L
1		U3	IC, CMOS OP AMP, TLC274C
1		U4	IC, Driver, RS422, SN75158
1		U5	IC, CMOS TIMER, SAF3019
1		XTAL1	Crystal, 3.6864 MHz
1		XTAL2	Crystal, 32,768 Hz
1		XFORMER	Transformer, Wall, 9V, 500MA
1		PROBE	Temperature probe
1			Socket, IC, 8 pin
1			Socket, IC, 14 pin
2			Socket, IC, 16 pin
1			Socket, IC, 40 pin
1			PCB, Clock
1			PCB, Display

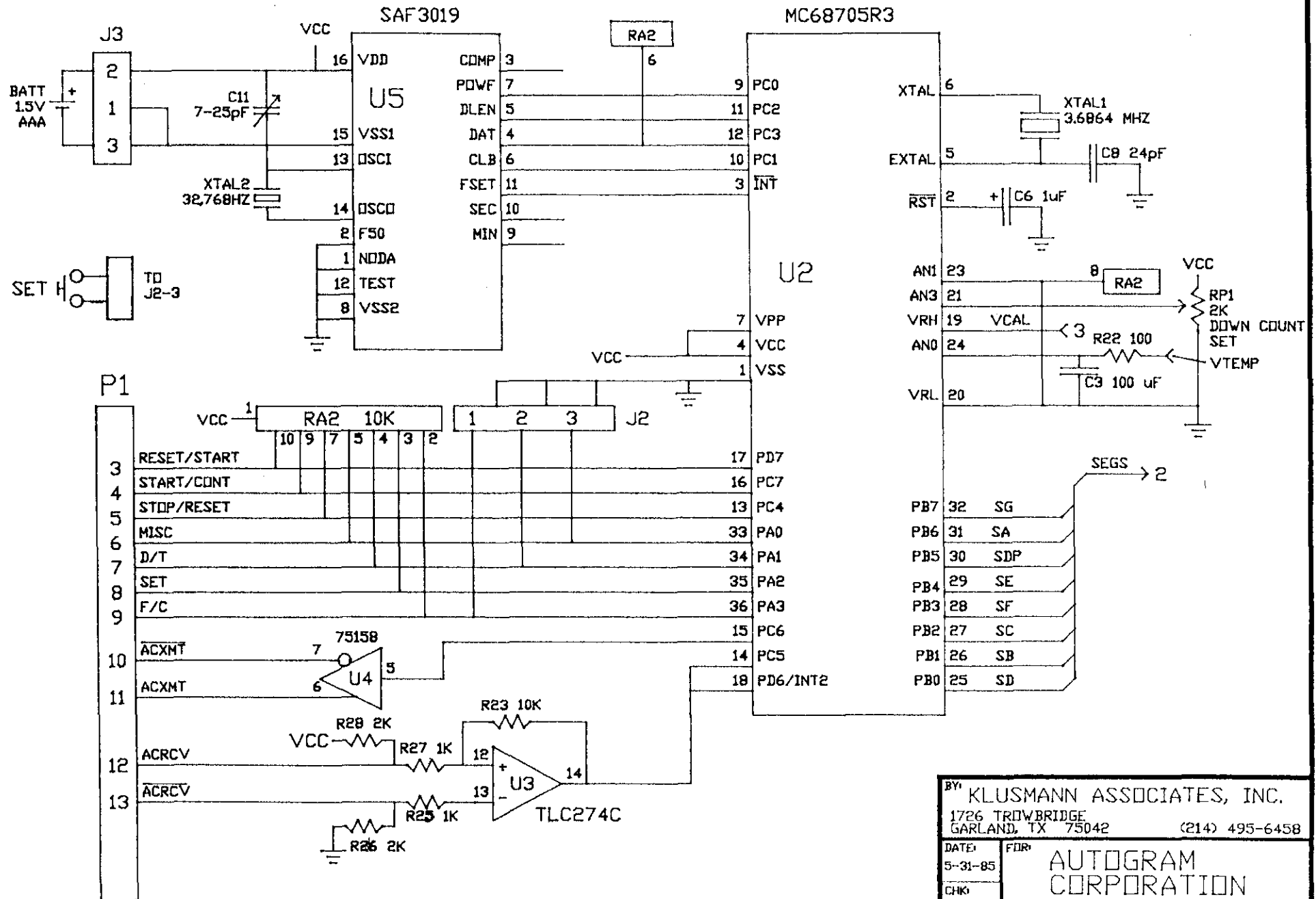
APPENDIX A - PARTS LIST/SCHEMATIC (continued)

QTY	PART NUMBER	DESIGNATOR	DESCRITPION
1			Chassis Assy, AUTOCLOCK
2			Card edge guide
1			Filter, Red
1			Bezel
1			Battery holder, AAA
1			Battery, AAA
1			Connector, Card edge, 2 X 15



P2





BY: KLUSMANN ASSOCIATES, INC.
 1726 TROWBRIDGE
 GARLAND, TX 75042 (214) 495-6458

DATE:	5-31-85	FIRM:	AUTOGRAM CORPORATION
CHK:	DLK		
PAGE:	1 OF 4		AUTOCLOCK

APPENDIX B - COMMUNICATIONS PROTOCOL

The communications protocol used by the AUTOCLOCK includes a one byte HEADER to identify a message (TIME/DATE/TEMPERATURE), a 3 to 7 byte MESSAGE, and a BCC block check character to verify the message has been recieved properly.

```
-----
!  HEADER  !           MESSAGE           !   BCC   !
-----
```

The communication parameters are as follows:

```
BAUD RATE:      300
BITS/BYTE:      8
PARITY:         EVEN
Driver/receiver: RS422
```

The communication message contents are as follows:

NOTE: BCC = The block check character.
The EXCLUSIVE-OR of the header and message bytes.

TIME MESSAGE

```
-----
!  01  !  HH  !  MM  !  SS  !  BCC  !
-----
```

HH = Hours (00-23) in BCD format.
MM = Minutes (00-59) in BCD format.
SS = Seconds (00-59) in BCD format.

DATE MESSAGE

```
-----
!  02  !  DOW !  MON !  DOM !  YY  !  BCC  !
-----
```

DOW = Day Of Week (01-07) in BCD format.
01 = Sunday ... 07 = Saturday
MON = Month (01-12) in BCD format.
DOM = Day Of Month (01-31) in BCD format.
YY = Year (00-99) in BCD format.

TEMPERATURE MESSAGE

! 03 ! TEMP ! TPH ! HHH ! MMH ! TMPL ! HHL ! MML ! BCC !

TEMP = Present temperature. *
TPH = Present HIGH temperature. *
HHH = Time (Hour) when HIGH occurred.
MMH = Time (Minute) when HIGH occurred.
TMPL = Present LOW temperature. *
HHL = Time (Hour) when LOW occurred.
MML = Time (Minute) when LOW occurred.

* NOTE: To calculate the temperature in degrees Celsius use the following formula (T = TEMP or TPH or TMPL):

$$C = (T/2) - 40$$

To calculate degrees Fahrenheit use:

$$F = (C*9/5) + 32$$