Models 773 and 773H
Timer-Counters
Operating and Service Manual

This manual applies to instruments marked
"Rev 23" on rear panel

WARNING

This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment 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.

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25901.0C:1084

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If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, EG&G ORTEC must be informed, either in writing, by telephone [(615) 482-4411] or by telex (55-7450) of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The EG&G ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped **PREPAID** via Air Parcel Post or United Parcel Service to the nearest EG&G ORTEC repair center. (In the case where the instrument did not function upon purchase, EG&G ORTEC will pay shipment costs both ways.) The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

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Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

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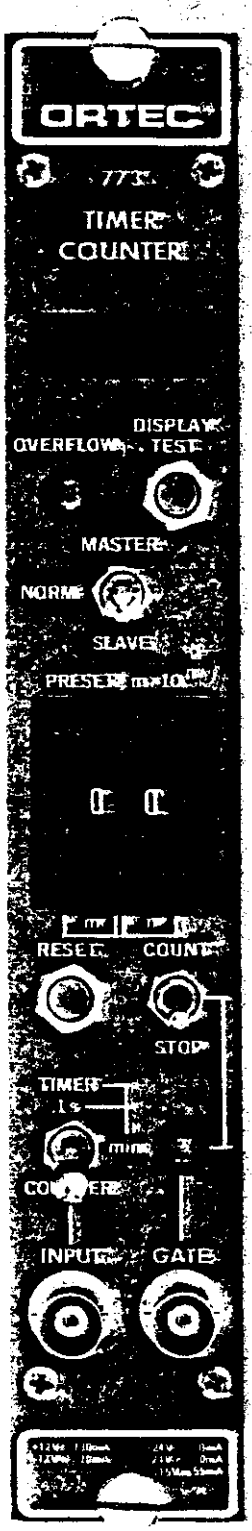
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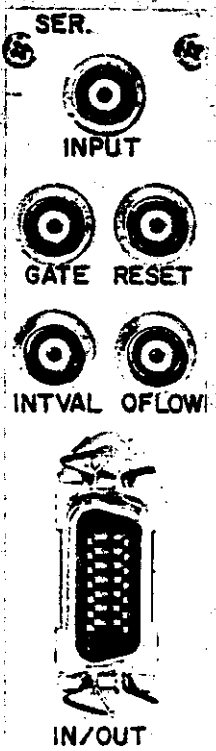
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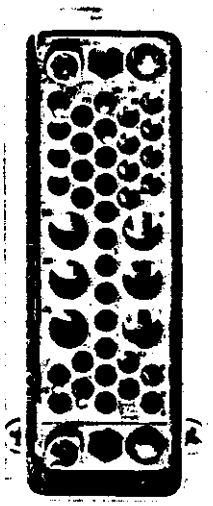


773 and 773H TIMER-COUNTERS MANUAL

1. DESCRIPTION

The ORTEC 773 Timer-Counter is a general-purpose 6-decade unit that includes a precision source of timing pulses and a preset circuit. It can be used in either a simple or a complex counting system to control the duration of a counting interval for all the Counters in the system. When it is operated as a Counter, it accepts and counts NIM-standard slow positive logic pulses. When operated as a Timer, it can count either 0.1-sec or 1-min intervals.

The 773 data, whether time or counts, can be printed together with data from any other ORTEC printing modules by an ORTEC 777 Line Printer or, through an ORTEC 432A Printout Control, by an ORTEC 222, which is a modified Teletype.

The unit is designed for preset timing control of a counting system that includes only one Counter or up to as many as 50 Counters. The associated signals through the rear panel of the 773 permit a flexible overall system control to be designed for a wide variety of associated system accessories.

The 773 is packaged in a NIM-standard single-width module. It includes all the connectors and controls that will be used for either manual or automatic operation and indicates the accumulated time or count with six 7-segment light-emitting diodes (LED) in a direct-reading display. When it is used as a Timer for 0.1-sec increments, a decimal point is included in the display. Insignificant zeros are blanked from the display automatically.

A gate indicator, which is also an LED, lights to show when the 773 is in a counting condition. The gate is controlled by the manual Count/Stop switch, by the Gate signal input circuit with BNC connectors on both the front and rear panels, and by a common line signal through the standard ORTEC printing loop In/Out connector on the rear panel.

If the preset function is disabled and the Counter is allowed to overflow, this overflow is shown by an LED on the front panel; the indicator remains lit from the first overflow until the unit is reset. At each overflow an output pulse is also furnished through a rear panel connector and may be used for connection to another Counter for an increased counting capacity.

If the preset function is enabled, by setting the Preset m thumb wheel at any digit between 1 and 9 and by selecting a decade multiplier, 10^0 through 10^5 by setting the Preset n thumb wheel at any digit between 0 and 5, the 773 stops whenever its count level reaches the combination that is selected. The preset condition is made available through the system preset line to stop all other Counters that are included in the printing loop.

Reset is generated automatically when power is first applied to the unit and can be provided manually or automatically by a signal through a rear panel BNC connector or through a common line in the standard ORTEC printing loop through the In/Out connector on the rear panel.

The seven segments in each of the six characters of the digital display can be tested at any time by pressing the Display Test switch on the front panel. When this switch is pressed, all seven segments in each digit should light to provide a reading of 888 888.

The 3-position locking toggle switch on the front panel marked Master/Norm/Slave selects the functional control of this module when it is connected in a standard ORTEC printing loop. The 773 responds to a common preset signal or furnishes it for any switch position and also responds to local gate control and reset for any switch position. But with the switch set at Master, this module can also furnish gate control and reset to all Slave modules in the system. When the switch is set at Slave, this module accepts gate control and reset from the system common lines. When the switch is set at Norm, it will neither furnish nor accept gate control and reset to or from the common lines. This operating selection permits the 773 to be used in combination with other printing modules with a very flexible control relationship.

The ORTEC 773H operates identically to the 773 but requires that the bin and power supply in which it is operated furnish +6 V dc as a power source. The ORTEC 401B/402H Bin and Power Supply is typical of the equipment required for this purpose.

2. SPECIFICATIONS

2.1. PERFORMANCE

Function Can be used as a Timer or as a Counter, but not as both simultaneously.

Count Capacity Six decades, for an indication of 0 or 0.0 through 999 999 or 99 999.9.

Time Base 0.1-sec or 1.0-min counting increments, time base derived from 1-MHz crystal-controlled oscillator.

Counting Rate (Counter Mode) 20 MHz, maximum.

Time Base Accuracy Within <0.0005%.

Time Base Stability Within <0.0001%/°C.

Synchronizing Error <1.0 μsec.

Pulse Pair Resolution (Counter Mode) Minimum 50 nsec with minimum 50% duty cycle at 20-MHz maximum count rate.

Automatic Clear Generated when power is turned on initially or after a power failure.

2.2. INDICATORS

Display 6 direct-reading 7-segment LED digits with automatic blanking of insignificant zeros. Decimal point included for 0.1-sec Timer operation.

Overflow LED, illuminated from the first overflow until reset.

Gate LED, illuminated while unit is in the counting or timing condition.

2.3. CONTROLS

Display Test Push-button switch illuminates all segments of each digit in the display when depressed; display reads 888 888.

Master/Norm/Slave 3-position locking toggle switch selects the timer-counter function when the module is connected in a data acquisition system. Master selects control over all slaves in the system by furnishing control signals through the common gate and reset lines. Norm isolates this module from system control through the common gate and reset lines. Slave accepts control from another module in the system, operating as a Master, that furnishes the system gate and reset signals and also responds to local gate and reset.

Preset A pair of thumb-wheel switches select a count (or time) level for a preset stop. One switch selects m and the other selects n in an m X 10^n format. Setting m at 0 disables the preset circuitry.

Reset Push-button switch resets the internal counting register and the display to zero when depressed.

Count/Stop Toggle switch selects counting (timing) or noncounting (timing off) condition manually for the module.

Counter/Timer 3-position locking toggle switch selects the source of pulses to be counted. Counter selects the input pulses furnished through the front or rear panel Input BNC connectors; Timer .1 s selects the pulses furnished from the internal timing system at 0.1-sec intervals; Timer 1 m selects the pulses furnished from the internal timing system at 1.0-min intervals.

2.4. CONNECTORS

Input Front and rear panel BNC connectors accept NIM-standard slow positive logic signals, ≥+3 V to count or ≤+1.5 V to not count; ±25 V maximum; ±25 nsec width; Z_{in} >2 kΩ, dc-coupled.

Gate Front and rear panel BNC connectors accept NIM-standard slow positive logic signals to control the counting register input gate and the Gate indicator. An open circuit or ≥+3 V enables counting (timing); ≤+1.5 V inhibits counting (timing); ±25 V maximum; driving source must be capable of sinking 0.5 mA of positive current.

Intval (Interval) Rear panel BNC connector furnishes a +5-V output level whenever the 773 is in a counting condition. Signal switches to ~0 V when counting is inhibited.

Reset Rear panel BNC connector accepts NIM-standard slow positive logic signals to reset the unit to an initial condition. ≥+3 V generates reset; ≤+1.5 V does not reset; protected to ±25 V; 100-nsec minimum pulse width. Z_{in} = 2 kΩ to ground, dc-coupled.

Oflow (Overflow) Rear panel BNC connector furnishes standard positive logic output, +5 V for 2 μsec, each time the Counter overflows from 999 999 to 0. Driving source impedance <10Ω to ground, dc-coupled.

In/Out Rear panel Amphenol type 57-40140 connector includes four common data lines and all system logic for the standard ORTEC printing and/or counting system interconnections.

2.5. OPTION

773H Timer-Counter The 773H is a complete Timer-Counter that is equal in performance to the 773 and differs only in that it requires +6 V from the Bin and Power Supply.

2.6. ELECTRICAL AND MECHANICAL

Power Required For the 773 Timer-Counter: +12 V, 130 mA; −12 V, 70 mA; 115 V ac (50 or 60 Hz), 55 mA. An internal power supply generates the +5-V source that is required by the integrated circuits; protected by a chassis-mounted 1-A 3AG fuse.

For the 773H Timer-Counter: +12 V, 130 mA; −12 V, 70 mA; +6 V, 600 mA. Must be operated in an ORTEC 401B/402H Bin and Power Supply or equivalent.

Dimensions Standard NIM single-width module (1.35 X 8.714 in.) per TID-20893.

2.7. ACCESSORY INCLUDED

Cable One ORTEC 772-C1 printing system control cable for interconnection with other ORTEC printing Counters, Timers, Digital Ratemeters, etc., in an ORTEC standard printing loop.

3. INSTALLATION

3.1. GENERAL

The 773 operates on input power that must be furnished from a Nuclear-standard Bin and Power Supply such as the ORTEC 401/402 Series. If any vacuum tube equipment is operated in the same rack with the 773, there must be sufficient cooling air circulating to prevent any localized heating of the integrated circuitry used throughout the 773. The temperature of equipment mounted in racks can easily exceed the maximum limits of 120°F (50°C) unless precautions are taken.

3.2. CONNECTION TO POWER

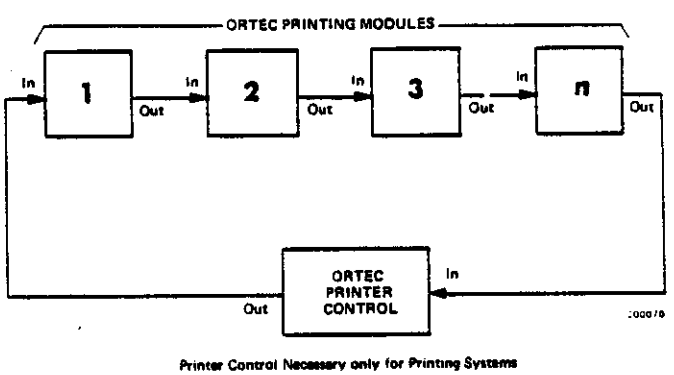
Turn off the Bin Power Supply when inserting or removing any modules. The ORTEC modules are designed so that it is not possible to overload the Power Supply with even a full complement of modules in the Bin. Since, however, this may not be true when the Bin contains modules other than those of ORTEC design, the Power Supply voltages should be checked after all modules have been inserted. The 401/402 has test points on the Power Supply control panel to permit monitoring the dc voltages easily.

The 773 requires 115 V ac as one of its power inputs. Some bins and power supplies, as well as jumper cables, may not be wired to include this power. In the event that the unit fails to operate in a new installation, check the bin and/or cable to determine whether the 115-V ac circuit is included.

The 773H version requires +6 V dc at 600 mA. It must be used with an ORTEC 401B/402H Bin and Power Supply or equivalent to satisfy this power requirement. No ac power is required for the 773H.

3.3. COUNTER INTERCONNECTION

When a counting system contains more than one 772 Counter or 773 Timer-Counter, the units are connected together as shown in Fig. 3.1. The In/Out connector on the rear panel of each module is used for this loop interconnection, and one cable is furnished with each of the printing modules to permit the loop to be formed. For nonprinting systems the order of interconnections is not important, but for printing systems the order of printing is 1 through n in sequence as shown in Fig. 3.1. Figure 3.2 shows how the 772-C1 cable provides the In and Out connections separately. Normally, after the modules have been connected together in a system, one of the modules will be selected as the Master for the system and the remaining modules will all be Slaves. The 773 Timer-Counter will usually be used to control the counting intervals with preset time and will logically be set as Master. All the 772 Counters in the system will be set for Slave.



Printer Control Necessary only for Printing Systems

Fig. 3.1. Counter Interconnection for System Operation.

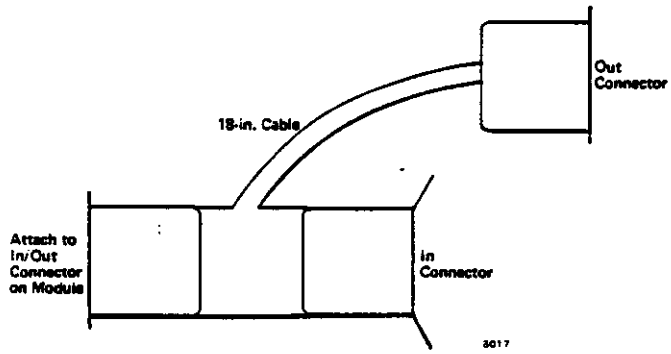


Fig. 3.2. Detail of 772-C1 Printing System Cable.

3.4. SIGNAL CONNECTIONS

Count Input When the 773 is used as a Timer, with the front panel locking toggle switch set at either .1 s or 1 m, the pulses that are counted in its counting register originate internally and no external connections are required. An internal 1-MHz crystal-controlled oscillator is counted down to provide each input pulse to the counting register. The countdown is 100 000 oscillator cycles for an output at 0.1-sec intervals or is 60 000 000 oscillator cycles for an output at 1-min intervals.

When the front panel switch is set at Counter, positive logic pulses can be accepted through the front or rear panel BNC Input connector. These two connectors are ***not isolated*** from each other; so signals from two sources should not be connected simultaneously to the two Input connectors. The input circuit in the 773 is dc-coupled to eliminate baseline shifts associated with changing counting rates. For signals with an average dc level greater than ±25 V, external capacitive coupling must be provided by the user. For dc levels below ±25 V, connection to the input can be made safely without damage to the 773. However, for the Counter to respond to any signals through the input circuit, the signals must rise from below +1.5 V to above +3 V with fast rise time and without any transients at or around +3 V.

Gate Input The gate input signal, if it is to be used, can be connected to the 773 at either the front or rear panel BNC Gate connector. These two connectors are ***not isolated*** from each other; so signals from two sources should not be connected simultaneously to the two Gate connectors. With no connection made to either of the connectors the counting register is enabled as far as the gating circuit is concerned. To cut off the gate the input circuit must be pulled down to below +1.5 V. To do this the driving circuit must be capable of absorbing 0.5 mA from the gate input circuit. The gate circuit permits counting when the gate input is at +3 V or greater or is open-circuited.

Reset Input The reset input signal can be connected to the rear panel BNC connector. To reset the Counter and Timer circuits to zero a signal of +3 V or greater is required with a minimum width of 100 nsec. The input impedance is approximately 2 kΩ and is dc-coupled to ground. Negative input signals will not perform any useful function at the reset input. The input circuit will not be harmed by an input that does not exceed ±25 V.

Overflow Output An overflow output signal is available through the rear panel Oflow BNC connector. A positive 5-V signal appears at the output each time the contents in the counting register change from 999 999 to 0. The output signal is 2 μsec wide. Z_o is <10Ω, dc-coupled.

Interval An interval output is available through the rear panel Intval BNC connector. This output is at nominally +5 V whenever the 773 is in a counting condition, and changes to a nominal 0 V when counting is inhibited. The output is dc-coupled. Z_o <10Ω.

In/Out System Connector Signals An adapter cable, 772-C1, is furnished with the 773 to attach to the In/Out connector and to make separate connectors available for the In and Out system interconnections. The signals at the In and Out connectors are listed in Table 3.1. The physical details of the 772-C1 cable are shown in Fig. 3.2; the system In connector is located on the opposite end of the connector block from the portion that attaches to the In/Out connector on the rear of the module, and the Out connector is on the remote end of the 18-in. multiwire cable that extends to the next module in the loop.

Pin 7 on the In/Out connector is the Previous Module Finished (PMF) signal from pin 7 of the In connector. Pin 13 on the In/Out connector is the This Module Finished (TMF) output to pin 7 of the Out connector. All the remaining pins are wired point-to-point between all 3 connectors in the cable.

Table 3.1

In Connector		Out Connector	
Pin	**Description**	**Pin**	**Description**
1	Data 1	1	Data 1
2	Data 2	2	Data 2
3	Data 4	3	Data 4
4	Data 8	4	Data 8
5	Print	5	Print
6	Print Advance	6	Print Advance
7	Previous Module Finished	7	This Module Finished
8	System Gate	8	System Gate
9	System Preset	9	System Preset
10	System Reset	10	System Reset
11	Ground	11	Ground
12	432 Off	12	432 Off
13	Spare	13	Spare
14	This Module Printing	14	This Module Printing

Pins 12 and 14 carry an identification of 432 Off and This Module Printing signals respectively. They are used in other ORTEC printing modules if their count capacity is other than 6 decades; so they are wired through the loop but are not used in the 773.

The functions of signals through the 14 pins of the In/Out connector are as follows:

Pins 1–4 — Data Lines Transfer the four bits of each digit from the assigned instrument to the Printout Control. Each instrument includes an isolated program control that drives these common lines only during its turn for printing.

Pin 5 — Print Prepares the instrument for data transfer during printing.

Pin 6 — Print Advance Advances the scanner in each instrument for readout of each of its digits during printing.

Pin 7 — Previous Module Finished Starts the actual data transfer from an instrument when it is its turn to be printed.

Pin 8 — System Gate Carries a gate-off signal to all instruments set for Slave operation in the system loop. The signal originates in a Master instrument, and this can be the 773. When the 773 is set for Slave, the system gate line will affect that Counter. When the 773 is set for Master, a gate input will be imposed on the system gate line. A Counter that is set for Norm is isolated from the system gate line.

Pin 9 — System Preset Carries a preset signal to all instruments in the system loop. A preset condition gates off all modules in the system.

Pin 10 — System Reset Carries a reset signal to all instruments in the system loop except any that may be set for Norm. This signal originates in a Master module or in the 432A Printout Control.

Pin 11 — Ground Carries a common zero potential line to all modules in the system loop.

Pin 12 — 432 Off Has no effect on the 773.

Pin 13 — This Module Finished Signals the next instrument to start its data transfer.

Pin 14 — This Module Printing Has no effect on the 773.

4. OPERATING INSTRUCTIONS

4.1. FRONT PANEL CONTROLS AND INDICATORS

The following functions are indicated and controllable from the front panel:

Count/Stop Manually controls counting of the 773; Count position permits counting and Stop position inhibits counting.

Gate Indicator An LED indicates the condition of the input gate. When it glows, the 773 is able to count timer or input pulses. When it is dark, the 773 is inhibited from counting.

Reset A push-button switch resets the contents of the Counter and Timer to zero when it is depressed.

Master/Norm/Slave A 3-position locking toggle switch that controls the functional position of the 773 when it is used in an ORTEC printing system. The switch does not affect the operation of the Timer-Counter unless printer loop cables are connected to the rear panel. See Sections 4.4 and 4.5 for further information.

Preset A set of two digital thumb-wheel switches permits selection of a preset count level. The switch at the left, marked m, selects any single significant digit, 1 through 9. When this switch is set at 0, the preset function is turned off. The switch at the right, marked n, selects a power of 10 for a multiplier factor applied to the selected significant digit; usable settings are 0 through 5. For example, if m is set at 4 and n is set at 3, a preset stop at 4×10^3 (4000) counts is selected in the 773 register. The counts can be 4000 input counts, 400 sec, or 4000 min, depending on the setting of the Counter/Timer switch.

Overflow Indicator An LED lights if the counting register exceeds its capacity of 999 999 counts; remains lighted until the unit is reset.

Display Test A push-button switch permits a quick check of the digital display. When it is pressed, all seven segments of each of the six digits will be lighted, regardless of the counting register contents, and the display reads all "eights."

Digital Display Six 7-segment LED characters with logically selected blanking for each segment display the

Counter contents at all times except during printing intervals and the display test interval. Each digit is displayed during printing while it is being furnished to a Printer.

4.2. INITIAL OPERATION

1. Install the 773 into a 401/402 series Bin and Power Supply or equivalent and turn on the power.

2. Set the Count/Stop switch at Stop and the Counter/Timer locking toggle switch at 0.1 s. This will select operation as a Timer with 0.1-sec units.

3. Press Reset. The display should now indicate that the contents are zero; the display reads 0.0.

4. Press Display Test. The display should read 88888.8 and should return to 0.0 when the switch is released.

5. Set the Count/Stop switch at Count. The Gate indicator should light and the 773 should start counting time in 0.1-sec units. Set the switch at Stop and the light should go out and the Timer should stop counting time. Return the switch to Count again.

6. Ground the Gate input and observe that the counting stops and the Gate indicator LED is not lighted. Remove the ground and restore the counting condition.

7. Select some random preset number with the two thumb-wheel switches that is greater than the accumulated time indication. Observe that the unit stops counting time at the preset level; the Gate indicator should also turn off at this time.

8. Set the Counter/Timer locking toggle switch at 1 m (for 1.0-min units).

9. Press Reset to restore an initial zero condition. Since this will have removed the Preset stop control of step 7, the unit should light its Gate indicator and start counting time immediately.

10. Check the operation of the 773 as a Counter. Provide positive logic pulses into either the front or rear panel BNC connector marked Input, and set the locking toggle switch at Counter.

11. Press Reset to restore the zero condition in the counting register. Note that the decimal point in the digital display does not light and that the zero count level reads 0.

12. Check the functions of the Count/Stop switch, the Gate input, and the Preset thumb-wheel switches as outlined for the Timer function of the 773.

4.3. COUNTING SETUP WITH ONE COUNTER

Proceed as outlined in Section 4.2 but omit those steps used in "testing" the instrument. Be sure that the input signals do not exceed the ±25-V limits.

4.4. COUNTING SETUP WITH MULTIPLE COUNTER-TIMER MODULES

Preferred Setup In a multiple-counter setup each Counter should be inserted into the Bin and Power Supply and connected together with the printer loop cables as shown in Fig. 3.1 (without the Printer Control). For nonprinting systems the sequential arrangement of the cables is not important.

With the units properly connected together the individual count and gate signal connections are made to the respective Counters. When all units have been installed, testing of individual Counters can be performed by operating each unit in either its Master or Norm mode. This frees the unit under test from all other units in the system except for a preset condition. If the Gate indicator does not light or if the counter does not accumulate counts during this phase, check to see whether the 773 has reached preset time. Any module that reaches preset will stop all modules from counting. This can be eliminated during the setup phase by setting m = 0.

After the individual Counters have been set up and tested for proper operation, the Master/Norm/Slave switches can be set as desired. Normally in a counting system one Counter or Timer will be selected as the Master and all the others will be set for Slave. With this arrangement the entire counting system can be controlled for reset and gating from the Master. The Count/Stop switch on the Master or its gate input could be used to start and stop accumulation in all the Counters and Timers, and the Reset push button on the Master would reset all of the system. In addition to the overall system gating control from the Master, if there are any gate input signals furnished to any of the Slave units or if any have a reset signal or manual command, each such signal will affect only the Slave unit in which it originates. It is important to remember that a Counter selected to operate in the Norm mode cannot be reset or gated by a Master unit, but will respond only to a preset signal in the system in addition to any signals that originate in that particular module.

Alternate Connections for One or Two Counters with a Timer The module interconnection scheme shown in Fig. 3.1 is the preferred manner of connecting more than one Counter or Timer into a data system because of the flexibility it offers and the simplicity of interconnections. There is, however, an alternate connection for a simple setup involving a 773 Timer-Counter and one or two 772 Counters without using the printer loop cables. A coaxial cable connected from the rear panel Intval (Interval)

connector of the 773 to the Gate Input connector on each Counter will allow the Count/Stop switch on the Timer and its Preset to start and stop counting and timing together, providing all Counters are set for the Count condition. When the 773 reaches preset time, the Counters stop counting.

If in the setup described above the 773 Timer-Counter had been operated as a Counter, the 772 data would have represented the number of counts above its threshold per m x 10^n (preset condition) counts from another source that was being counted in the 773. The ratio of two counting rates can be determined in this manner.

4.5. PRINTING SYSTEMS

The 773 Timer-Counter is designed to operate as a part of an automatic data acquisition system, from which all data can be printed by either an ORTEC 777 Line Printer or, with an ORTEC 432A, by an ORTEC 222 (modified Teletype). The 773 Timer-Counter is operated the same for either of these two serial printing accessories.

The 773, upon command, provides the data stored in its counting register to the 777 Line Printer or the 432A Printout Control and the 222 Teletype in a serial-by-character format. The data are fed out in six groups (characters), from the most significant digit to the least significant digit, at a rate determined by the printout accessory. Each group or character is composed of four bits of information in a 1-2-4-8 BCD code, with logical one being about +6 V and logical zero about 0 V. Figure 4.1 shows the sequence of events for a single Counter that contains the accumulated count level 705 849. As a note of explanation, the Print Command signal originates in the 432A or 777. It can be initiated manually, be triggered externally, or be initiated automatically by a module in the system reaching a preset

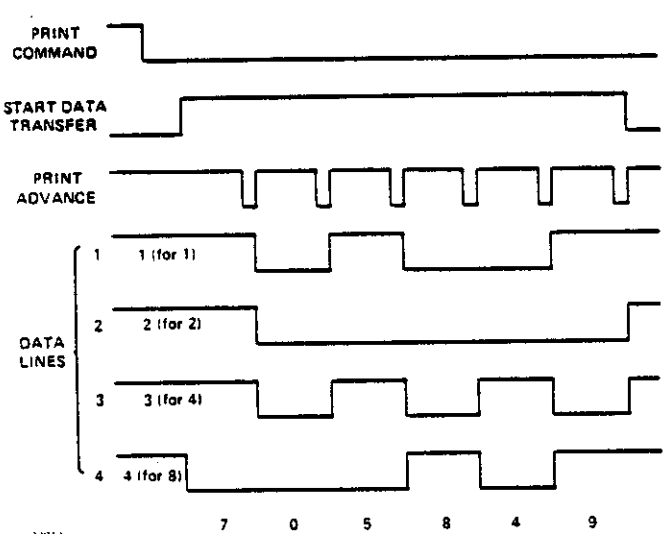


Fig. 4.1. Signal Sequence for Transferring Data for 705 849 from a Printing Scaler to the Printout Control.

condition. The Start Data Transfer is supplied from the 432A or 777 to Counter 1 (Fig. 3.1), from Counter 1 to Counter 2, from Counter 2 to Counter 3, etc. In other words, as each module finishes transferring its data, it sends a signal to the following module to allow its data transfer to begin. In the system the Start Data Transfer signal is called Previous Module Finished on the In connectors of the cables and This Module Finished on the Out connectors.

The following sequence of events illustrates how a multiple-counter printing system with a 432A Printout Control and a Teletype operates:

1. A Print Command is generated manually, by a trigger, or by a preset condition.

2. All Counters and Timers in the system stop accumulating and remain static for 1 or 2 sec.

3. All displays are blank except the most significant character in the display of Counter 1; this digit is lighted until the digit has been accepted by the output device.

4. Each of the remaining five digits in Counter 1 is printed in succession, and, as each digit is being printed, it is also illuminated in the display of the counter.

5. A space is generated in the printed format after the six digits that represent the data in Counter 1.

6. The six digits for Counter 2 are printed in succession.

7. A space is formed as in step 5.

8. This sequence repeats until the last counter has finished printing. Carriage return and line feed replace the space function at appropriate times in the program.

9. After the last set of data has been printed, one of two basic modes can be selected at the 432A: (a) the system will remain in a static or noncounting mode until a new cycle is started, and the display will be turned on, or (b) a system reset is generated and data accumulation will be repeated.

The program for use with the ORTEC 777 Line Printer operates as follows:

1. A Print Command is generated manually, by a trigger, or by a preset condition.

2. The 777 prints the entire data word. Since the 777 capacity is 7 digits per word, the first digit will automatically be a zero when any 6-digit Counter or Timer is being printed out.

3. The 777 has a line feed and advances the paper so that the next data word will appear on the next line.

4. The six digits for Counter 2 are transferred to the 777.

5. The 777 prints the second data word and then has a line feed.

6. This sequence repeats until the last Counter has finished printing. A double line feed in the 777 indicates completion of the data set.

7. After the last set of data has been printed, one of two basic modes can be selected by the 777: (a) the system will remain static or noncounting until a new cycle is started, and the displays in the modules will be turned on, or (b) a system reset is generated and data accumulation will be repeated.

5. CIRCUIT DESCRIPTION

5.1. GENERAL

Figure 5.1 is a block diagram of the 773 Timer-Counter. The complete schematic of the 773 is shown in 773-0101-S1 at the back of the manual.

As shown in Fig. 5.1, the pulses that are counted can be furnished either from the internal oscillator and countdown circuit or from the input circuit. If positive logic input pulses are selected, they pass through a synchronizer before they are counted. The purpose for synchronization is to prevent ambiguity of pulse recognition at the start or stop of a counting interval. The synchronization circuits include the control imposed by both local and system gate signals and by preset. Reset of the counting circuits can originate locally or from the system reset line. The control logic also includes routing to and from the system lines according to the selection that is made with the Master/Norm/Slave switch.

The 24 data lines, for the six 4-bit word groups from the counting register, are gated one word at a time to the four common data lines. These data lines lead into a decoder for the display and to the output for the printing loop. An internal scanner gates the four bits for a digit onto the four common lines and also selects the proper location in the display for that digit.

During nonprinting intervals the scanner is driven by an internal oscillator that operates at about 1 kHz and continually recycles the scan through the six digits. During printing intervals the internal oscillator is turned off and the scan is advanced at the rate of the printing accessory.

The 1-MHz oscillator furnishes pulses into a countdown circuit that can provide an output at either 0.1-sec or 1-min intervals. The front panel Counter/Timer switch selects which of the frequency divisions is to be used. The countdown circuit is reset to zero, together with the main

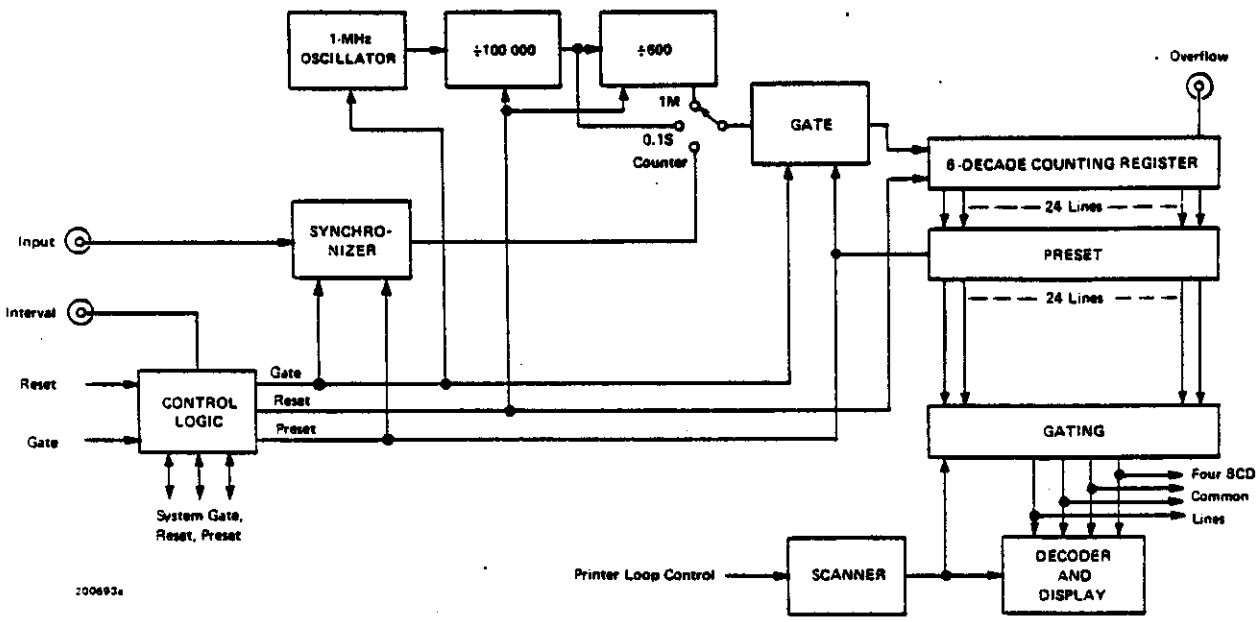


Fig. 5.1. Block Diagram of ORTEC 773 Timer-Counter.

counting register, by any reset that originates either locally or from the system.

5.2. TIMING OSCILLATOR AND COUNTDOWN

The crystal-controlled oscillator uses Q19 and the 1-MHz crystal to produce the output pulses. Capacitor C12 is a trimmer in the oscillator that is factory-adjusted for proper operation of the circuit. The output is furnished to the countdown input at pin 3 of IC 23.

The IC 23 package requires a high input at its pin 5 to count the oscillator input pulses. This is furnished from the Q output of IC 22, and is synchronized by an oscillator output pulse that follows the release of a gating control interval. The D input of IC 22 is held low during a gate-off condition and must be changed to high before the oscillator pulse at the C input can provide the Q output.

Switch S6 selects either 0.1-sec or 1-min intervals for the timer. When the switch is set at .1 s, the signal to pin 11 of IC 23 is low and the inverted signal (through IC 20-12) furnishes a high to pin 12 of IC 23. This logic combination selects a $\div 10^5$ countdown, and the output at pin 1 of IC 23 is a series of pulses at 0.1-sec intervals. When switch S6 is set at 1 m, this furnishes a high to pin 11 and a low to pin 12 on IC 23 and selects a $\div 6 \times 10^7$ countdown; the output at pin 1 of IC 23 is a series of pulses at 1-min intervals.

The output at IC 23-1 is the pulse that will be counted, but it must pass through IC 29-3, IC 29-6, IC 29-11, and IC 27-4 to reach the main counting register. IC 29-3 is enabled when switch S6 is in either Timer setting, and IC 29-6 is also enabled in this condition. IC 29-11 is enabled unless the unit has reached a preset condition. IC 27-2 is simply an inverter and does not have any gating conditions.

When switch S6 is set at Counter, IC 23 can operate and produce 1-min output pulses to IC 29-3, but IC 29-3 is inhibited by the low input to its pin 2 and will not pass the timing pulses. The entire countdown circuit in IC 23 is reset to zero by local reset (LR) when this is furnished from IC 32-6.

5.3. COUNTING SIGNAL SELECTION

When switch S6 is set at Counter, the pulses that are to be counted must be furnished through either CN1 on the front panel or CN3 on the rear panel. The low signal from S6 is inverted by IC 27-2 and furnished into IC 29-8. This enables IC 29-8 to pass the input pulses as they arrive at its pin 9.

5.4. COUNTER INPUT CIRCUIT

Standard positive logic pulses can be accepted through either CN1 on the front panel or CN3 on the rear panel, and are dc-coupled through Q10 to trigger synchronizing flip-flop IC 31-8 and -11 through IC 28-8 unless the triggering is inhibited by a gating condition. When the flip-flop is triggered, it sends a pulse out to IC 29-8 to be accepted for counting if the 773 is being operated as a Counter.

5.5. GATING

Local gating is controlled either by the toggle switch S4 or by a signal through Gate connector CN2 on the front panel or CN4 on the rear panel.

With switch S4 set at Stop the input to IC 35-11 is held low and the output signal at IC 35-8 is also held low. Flip-flop IC 31-8 and -11 is inhibited from accepting any input pulses by IC 28-8 from IC 32-8 through IC 36-12. This signal also sets flip-flop IC 31-3 and -6 so that the gating effect is retained until the first input pulse is received after the gate control is released. Since the low input to IC 33-6 provides a high output, there is no voltage difference across LED2 and the Gate indicator is not lit.

The low level output from IC 36-12 is also furnished into the D input of IC 22. This sets the $\overline{Q}$ output of IC 22 high and its Q output low. The Timer countdown circuit, IC 23, is inhibited from counting the 1-MHz oscillator pulses while Q is low. $\overline{Q}$ is furnished to IC 37-8 which, if enabled, generates a system gate output through IC 36-4 and Q15. It also is inverted by IC 38-4 to provide a low signal at the Intval (Interval) output connector, CN6, through Q9.

If a gate input signal is furnished through CN2 or CN4, it is applied to IC 32-8 through Q11 to provide the same control as the Stop setting of switch S4.

When switch S4 is set at Count and there are no gate input signals, the status of the circuit is inverted and the next input pulse (or 1-MHz oscillator pulse) resets the synchronizers to permit counting.

Gate IC 32-8 has two additional input circuits that are discussed separately. The signal at pin 12 can be furnished from the system gate line in the printer loop if switch S2 is set at Slave. The signal at pin 13 is the gate-off signal from either local or system preset.

5.6. COUNTING REGISTER

The counting register includes decades IC 14 through IC 19. They are connected to form a ripple counter for all six digits of the 999 999 count capacity. IC 14 is the least significant digit and IC 19 is the most significant digit. The BCD identification of each digit is carried through four lines to a set of gates that will pass the identity through to four common BCD lines when gated by the scanner.

The overflow from IC 19 is coupled through C26 to generate an output pulse through CN7 unless the 8 bit of IC 19 goes low because of a reset rather than by a counting overflow. The first overflow after a reset will also set flip-flop IC 24-3 and -6 to light LED1 until the next reset.

5.7. PRESET CIRCUIT

The preset circuit includes both sections of switch S3 on the front panel. Section S3A, marked m, selects any digit between 0 and 9, and section S3B, marked n, selects any decade level between 0 and 5. The resulting preset level is equal to $m \times 10^n$.

One decade is formed by IC's 25 and 26. It counts the input pulses that are selected by S3B and outputs a high level through the selection of S3A when the count reaches the set level. After the effective pulse has also been counted in the main counting register, all inputs to IC 28-6 will be high to generate an internal preset signal. If switch S3A is set at 0, no preset can be generated.

When preset is generated, it inhibits IC 29-11 and provides a gate-off condition through IC 35-3 and IC 36-12 to IC 32-8. The signal (low) is inverted by IC 34-2 to generate system preset through IC 35-6, IC 36-8, and Q13 and to clamp the interval output at 0 through IC 38-2 and Q9. Preset remains until LR and $\overline{LR}$ are generated by IC 32-6 and IC 27-12.

5.8. SCANNER

The scanner generates the Z1 through Z6 signals in sequence. It gates the most significant digit onto the common lines first with Z1; then it gates each less significant digit in order through Z6. When no print signal is furnished from the printer loop (nonprinting condition), an internal oscillator advances the scanner. When a print signal is present (printing interval), the scanner counts print advance input signals between the PMF and TMF signals; it scans through the available digits only one time during the printing cycle.

The internal oscillator uses IC 20-2 and -4 to generate an output signal at about 1 kHz. The output feeds through IC 21-3 and -8, unless a print signal is present, and to the clock input of IC 11. The BCD output of IC 11 is fed to the 10-line decoder, IC 10. When all four IC 10 input bits are zero, it identifies 0 at its pin 1 output; this generates $\overline{Z1}$ at IC 10-1 and Z1 at IC 9-2. The next oscillator pulse changes the count for a $\overline{Z2}$ output at IC 10-2 and Z2 at IC 9-4. This sequential signal generation continues until each signal has been generated in turn and an oscillator pulse advances the counter out of its Z6 condition and back to Z1. The scan is recycled immediately.

5.9. DECODER AND DISPLAY

The four bits that are present on the common line at any time represent one of the digits. This combination is decoded in IC 1 and furnishes the correct configuration of blanking and illumination to the seven LED segments at the anodes of all six digits in the display, LED3. The scanner signal will have selected which of the six digits in the counting register is gated onto the four common lines, and the same signal completes the cathode path for the proper digit in the display. For example, when Z6 is present, the cathode for the least significant digit in the display is selected, and the digit is identified through IC 3, the four common lines, IC 2, and IC 1 to the segments of LED3 for that digit.

For reference, the seven segments are identified *a* through *g*. Viewed from the front of the display, segment *a* is across the top; segment *b* is the top half of the right side; *c* is bottom right; *d* is across the bottom; *e* is lower left; *f* is upper left; and *g* is across the center. Any digit between 0 and 9 can be obtained by selective blanking of these segments. When switch S1 is pressed, IC 1 provides no blanking for any segment and the display should illuminate all segments for a reading of 888 888.

IC's 24-11, 13-11, 13-8, 13-6, and 13-3 provide the control for automatic blanking of insignificant zeros in the display. At Z1 time, for the most significant digit, IC 1 receives a signal from IC 13-6 to blank all segments if all inputs to IC 1 are low. Internal logic in IC 1 resets the blanking control through IC 13-3 when it identifies any digit other than zero from the four common lines. So until there is a digit that is not zero, nothing can be shown in the display. When switch S6 selects .1 s and the scan reaches Z5, the signal at IC 24-11 will remove blanking through IC 13-8 if it had not been removed by a nonzero digit prior to that time; the two least significant digits are displayed for the 0.1-sec Timer operation. When switch S6 selects either Counter or 1 m, the scan must reach Z6 to remove the automatic blanking through IC 13-11 and IC 13-8; the one least significant digit is always displayed.

When switch S6 is set at .1 s, a decimal point is illuminated in the display between the two least significant digits. This decimal point is selected, together with the Z5 digit, by a signal through IC 24-8 and IC 38-6. The decimal point circuit is not active unless switch S6 is set at .1 s.

When the 773 is reset and switch S6 selects .1 s, the display reads 0.0. At reset, with S6 set at either Counter or 1 m, the display reads 0.

5.10. PRINTING CIRCUIT

A printing loop is formed by cabling the printing modules and either an ORTEC 777 Line Printer or 432A Printout Control in a circuit as shown in Fig. 3.1. In normal operation all Counters and Timers in the system can count until a system preset signal occurs; then all modules stop counting and the accumulated data are transferred out to a printer, one module at a time. At system preset all modules are gated off and the control module generates a print output.

In the 773 the system preset is generated at IC 28-6 or is accepted through Q12 to turn off the input gate through IC 35-3, IC 36-12, and the gating circuit through IC 32-8. This prevents any advance of the counting register. The print

signal is accepted through pin 5 of the PL connector and Q3 to inhibit oscillator gate IC 21-3, to reset the scanner to Z1 through IC 20-8, IC 21-6, and IC 20-6, and to clamp all four gates of IC 2 to provide a "code 15" input to IC 1 that blanks the display. The module then waits until its turn to be printed out. A Previous Module Finished input from the printer loop signals the start of the printing cycle for the module; PMF originates in the control module if the 773 is Counter 1 in the system of Fig. 3.1 or is the TMF output from the previous Counter for any of the other positions in the loop.

The PMF input releases the reset latch at IC 21-6, releases the blanking clamp to IC 2, and enables gates IC 12 to transfer the data from the four common lines in the 773 to the system common lines. The most significant digit is gated from IC 19 through IC 8 by Z1 for transfer to the Printer and to the display. At print advance, when the digit has been accepted by the Printer, the signal through Q4 and IC 21-8 advances IC 11 for the Z2 digit that is in IC 18. Each subsequent print advance selects the next digit until Z6, after which IC 22 generates a TMF output and restores the off-line condition of the 773.

When the last module in the loop furnishes TMF to the control module, the control module determines the next sequence. It can remove preset, generate reset, or whatever is appropriate to the program that has been selected.

5.11. MASTER/NORM/SLAVE CIRCUITS

Switch S2 selects the mode of operation for this function. When the switch is set at Master, internal reset and gate signals are furnished to the system reset and gate lines for control of any other modules that are set for Slave. IC 37-8 permits the signals from $\overline{Q}$ on IC 22 to be furnished out to the system gate line through IC 36-4 and Q15. IC 37-6 is inhibited from passing any signals that may be furnished from the system gate line through Q14 and IC 36-10.

With switch S2 at Master, IC 37-12 permits any reset signals that are furnished through the internal circuits from IC 33-8 to pass through IC 36-2 and Q17 to drive the system reset line.

If switch S2 is set at Slave, the above conditions are reversed; IC 37-8 inhibits an output to the system gate line and IC 37-6 accepts signals from the system gate line. Gate IC 37-12 inhibits local reset signals from reaching the system reset line, but a system reset signal can be accepted through Q16, IC 36-6, and IC 33-12.

If switch S2 is set at Norm, the system gate and reset lines are isolated from the internal functions in the 773. This is obtained by inhibit to IC's 37-8, 37-6, 37-12, and 33-12.

5.12. LOCAL RESET

Local reset (LR in the schematic) is generated at IC 32-6 if any of its inputs goes low. The inputs originate with switch S5, from CN5 through Q8 and IC 34-8, from Q18 at the time power is first applied to the unit, or from the system reset line through IC 33-12. When LR goes high, $\overline{LR}$ goes low and all counting circuits are reset to zero. If, in IC 19, this causes the 8 output bit to be reset, an overflow output would be generated if it were not inhibited by IC 30-12.

5.13. POWER SUPPLY

The 773 includes an internal power supply that operates with a 115-V ac input and generates the +5-V level that is required for operation of all the integrated circuits.

Transformer T1 furnishes secondary voltage, which is full-wave rectified and filtered, that is then furnished to the collector of Q22. Q20, Q21, and Q22 form a regulator for the +5-V output, and fuse F1 protects the power supply from overload. The fuse is type 3AG with a rating of 1 A, fast acting.

The 773H Timer-Counter does not include the portion of the power supply circuit that is shown in the block identified as 775-0100-1. It obtains its +5-V power from the +6-V source in the ORTEC 401B/402H Bin and Power Supply. In this version the collector of Q22 is connected directly to pin 10 of the rear panel power connector.

6. MAINTENANCE

6.1. GENERAL

The basic performance of the 773 Timer-Counter can be tested by following the procedure outlined in Section 4.2. This will not check the unit to its published specifications.

If the unit fails to respond properly during testing, use the information in Section 5 to determine the probable fault. Schematic 773-0101-S1 is included at the back of this manual.

6.2. FUSE REPLACEMENT

If the front panel display and indicators will not light, remove the module from the bin and take off the left side panel for access to the inside of its rear panel. Inspect fuse F1, mounted in a fuseholder on the rear panel. This fuse protects the +5-V power source and the indicators cannot be lit unless this power is present. Replace the fuse with a 1-A fast-acting type 3AG fuse only.

6.3. FACTORY REPAIR

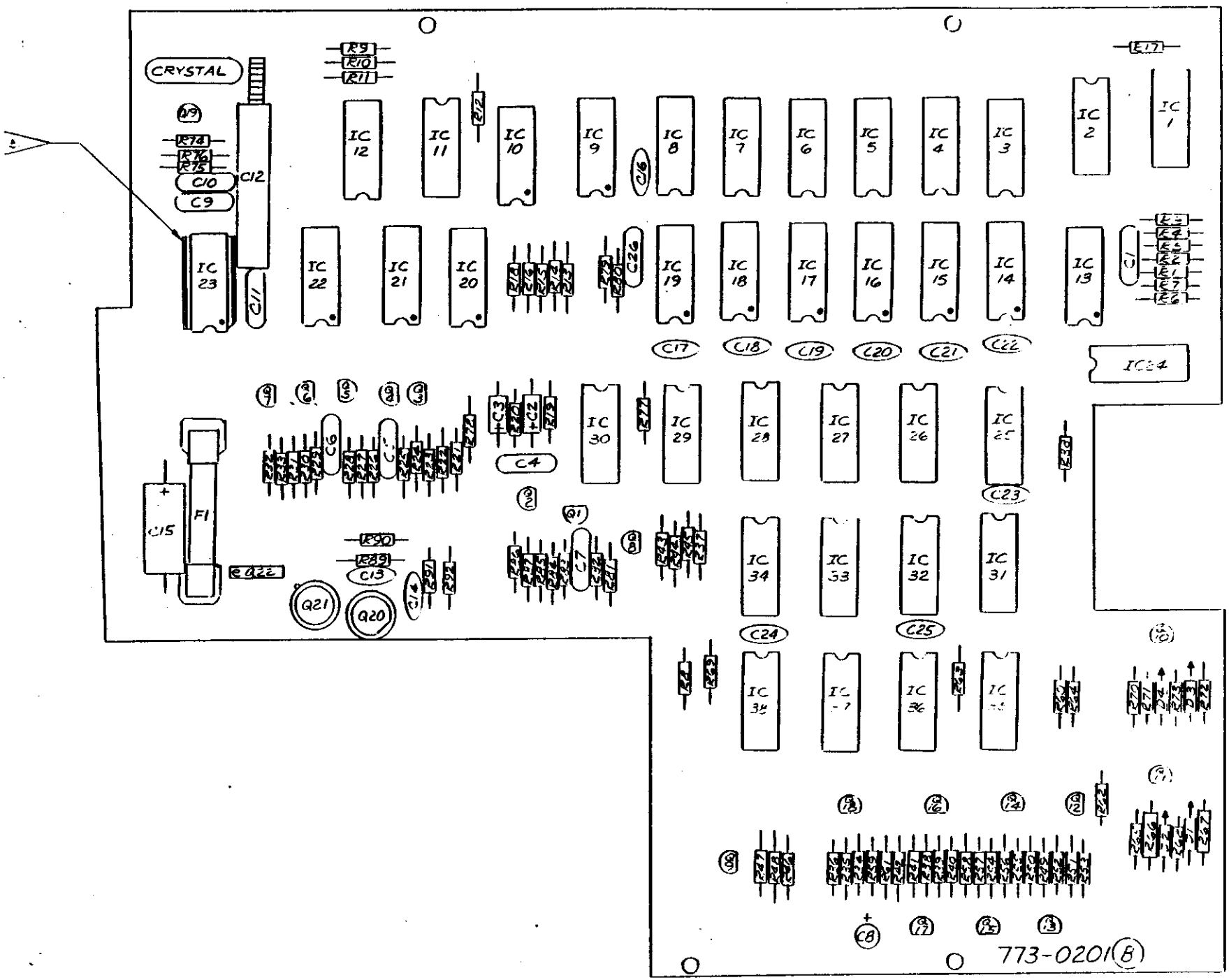
The 773 Timer-Counter may be returned to ORTEC for repair service at nominal cost at any time. Our standard procedure requires that each repaired instrument receive the same extensive quality control tests that a new instrument receives. Please contact our Customer Service Department, (615) 482-4411, before returning the instrument.

BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES PER TID-20893 (Rev 4) (adopted by DOE)

Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	−3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	−24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	117 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	**35	Reset (Scaler)
14	Spare	**36	Gate
15	Reserved	**37	Reset (Auxiliary)
*16	+12 volts	38	Coaxial
*17	−12 volts	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	117 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

Pins marked (*) are installed and wired in EG&G ORTEC's 4001A, 4001B, 4001C, 401A, and 401B Modular System Bins.

Pins marked (*) and (**) are installed in EG&G ORTEC-HEP-M250/N and M350/N NIMBINS.


CRYSTAL
R9
R10
R11
R74
R76
R75
C10
C9
C12
C11
C16
C26
C17
C18
C19
C20
C21
C22
C1
C15
F1
C4
C13
C14
Q21
Q20
Q1
C7
C23
C24
C25
C8
IC 1
IC 2
IC 3
IC 4
IC 5
IC 6
IC 7
IC 8
IC 9
IC 10
IC 11
IC 12
IC 13
IC 14
IC 15
IC 16
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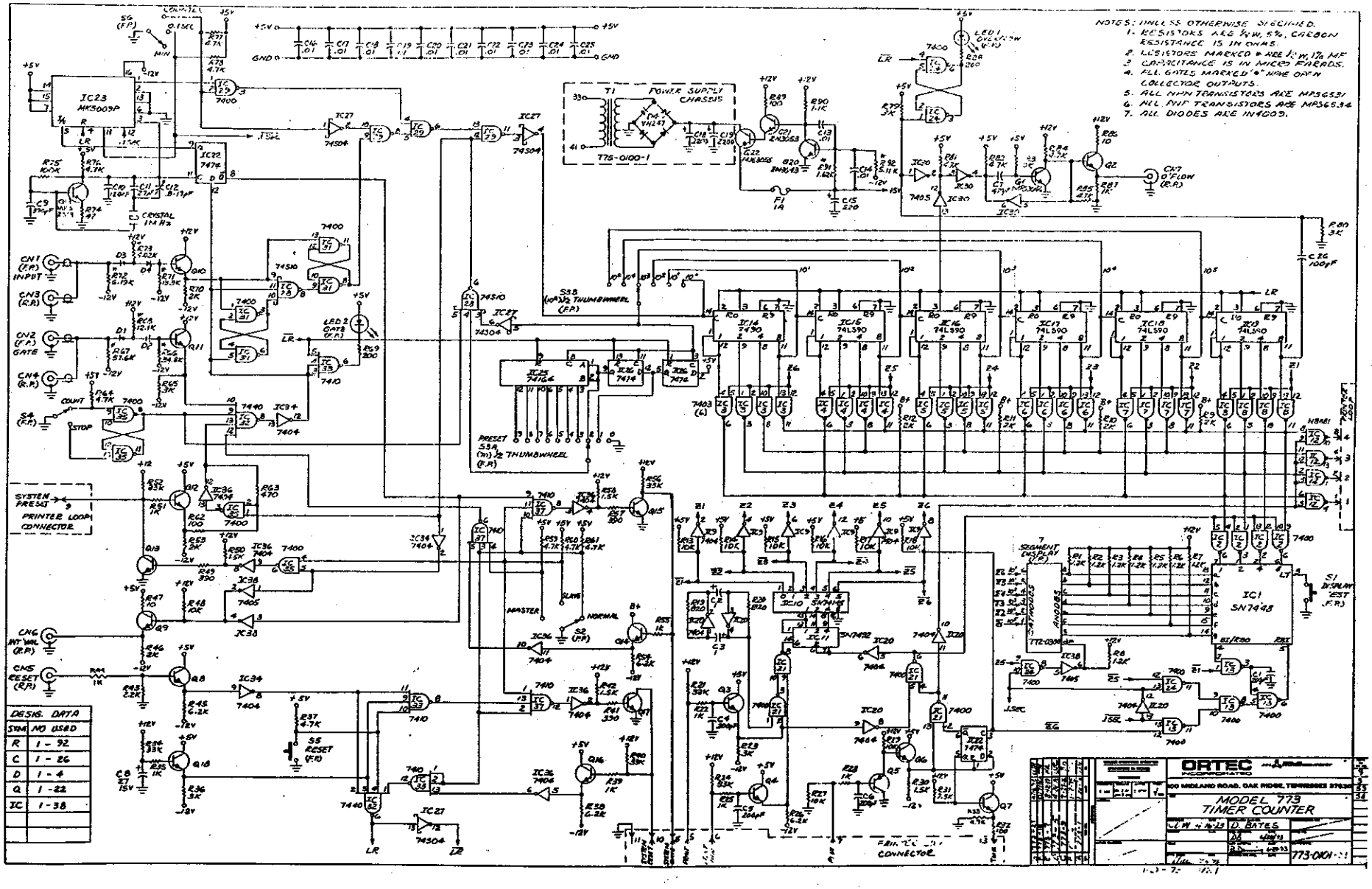
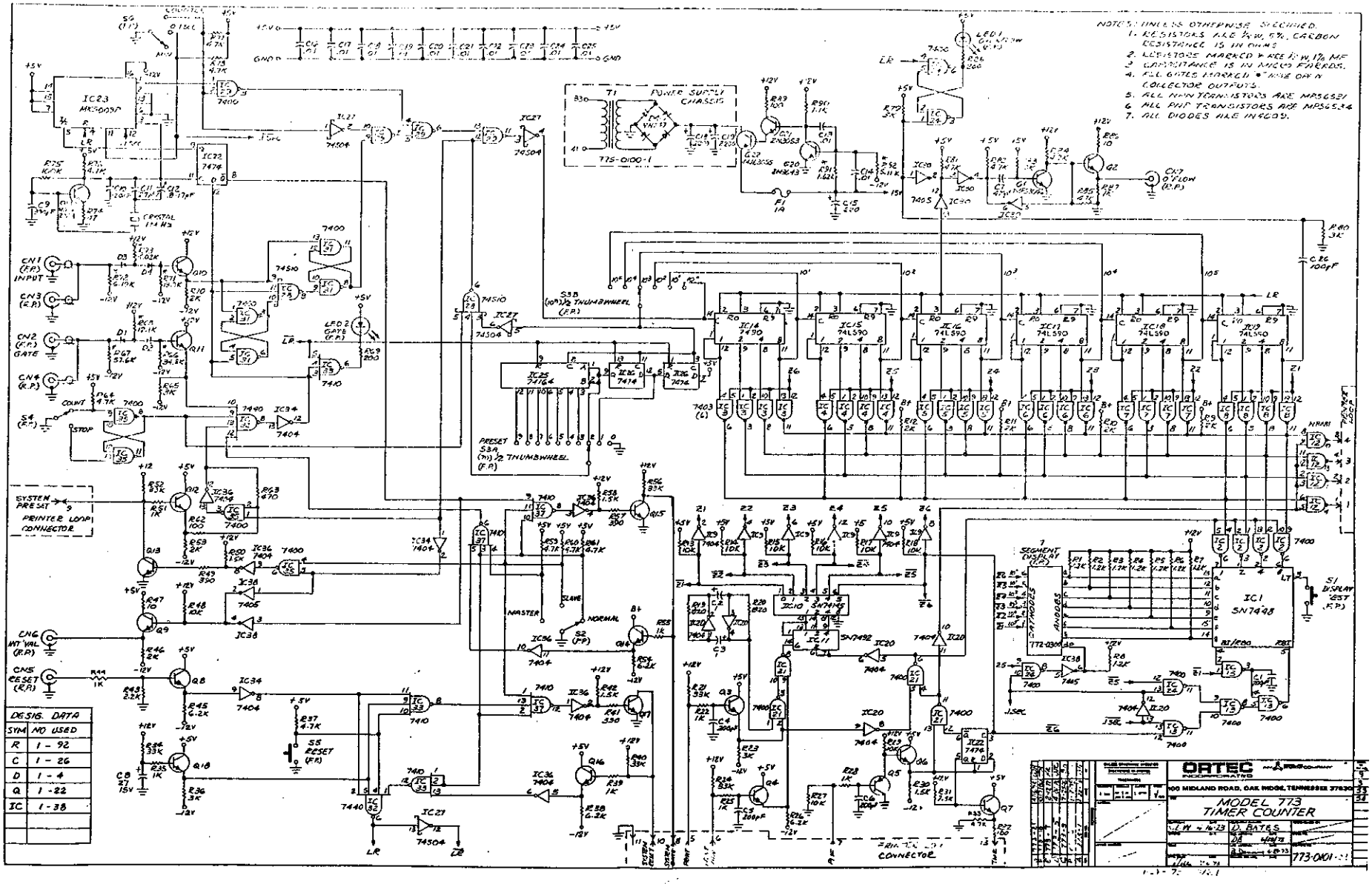
IC 35
IC 36
773-0201 (B)


NOTES: UNLESS OTHERWISE SPECIFIED.
1. RESISTORS ARE ¼W, 5%, CARBON. RESISTANCE IS IN OHMS.
2. RESISTORS MARKED * ARE ½W, 1% M.F.
3. CAPACITANCE IS IN MICRO FARADS.
4. ALL GATES MARKED 'o' HAVE OPEN COLLECTOR OUTPUTS.
5. ALL NPN TRANSISTORS ARE MPS6531
6. ALL PNP TRANSISTORS ARE MPS6534
7. ALL DIODES ARE IN4003.
T1 POWER SUPPLY CHASSIS
T75-0100-1
IC23 MK5009P
CRYSTAL 1MHz
SYSTEM PRESET
PRINTER LOOP CONNECTOR
S5 RESET (F.P.)
S1 DISPLAY TEST (F.P.)
S3A (10's) THUMBWHEEL (F.P.)
PRESET S3B (1's) THUMBWHEEL (F.P.)
MASTER
NORMAL
SLAVE
S2 (F.P.)
CN1 (F.P.) INPUT
CN2 (F.A.) GATE
CN3 (R.P.)
CN4 (R.P.)
CN5 RESET (R.P.)
CN6 INT. VAL. (R.P.)
CN7 O FLOW (R.P.)
LED 1 OVERFLOW (F.P.)
LED 2 GATE (F.P.)
S4 (F.P.)
COUNT
STOP
DESIG. DATA
R 1 - 92
C 1 - 26
D 1 - 4
Q 1 - 22
IC 1 - 38
ORTEC INCORPORATED
MODEL 773 TIMER COUNTER
D. BATES
773-0101-B



DESIG.	DATA
SYM	NO USED
R	1 - 92
C	1 - 26
D	1 - 4
Q	1 - 22
IC	1 - 38