flip-flop and the zero output of the flip-flop goes true. This true bit is applied to the First Character gate. The Punch Enable gate output goes true with the arrival of the next shape clock pulse.

first character gate

The First Character gate now has both inputs true. The true output of the First Character Gate is coupled to the Tape Punch solenoids in positions X, Y and Z. These solenoids are actuated and punch the 3 holes in positions X, Y and Z. X, Y and Z are punched only in the first character of a test sequence. This is true because as the first Punch Enable gate goes false this level is inverted and resets the First Character flip-flop. The zero output of the flip-flop goes false disabling the First Character AND gate. As long as Write Tape Command remains true no further punching in the X, Y and Z positions will take place. At beginning of a new tape sequence the flip-flop is set and X, Y and Z are again punched.

punch enable gate

The inverted Punch Enable gate is coupled out to the Type 240 as the Write Tape Clock, signalling the 240 to clock its registers for the next character. As long as Write Tape Command remains true the Punch Enable gate goes true with each clock and a new character is punched. As the 4.5 ms wide clock pulse goes false the 240 is clocked. Since clock occurs at 16.66 ms intervals approximately 12 ms is available to receive the next character from the 240 registers and advance the tape. This sequence of events continues until the Type 240 has clocked all characters stored in its registers to the tape punch. At that time the 240 ends the Write Tape Command. With Write Tape Command false no further action takes place in either the tape perforator unit or the tape perforator drive unit.

At the beginning of a new Write Tape sequence the entire action repeats. Coincident with the first character the X, Y and Z positions will be punched. This serves to give an operator an easy way of identifying the beginning of a measurement sequence when loading the tape into a tape reader.



# 4

# THE TYPE 240 PROGRAM CONTROL UNIT AND TYPE 250 AUXILIARY PROGRAM UNIT

The most complex instrument in the Memory and Control section of a system is the Type 240 Program Control Unit. The Type 240 contains facilities for programming; a sampling vertical such as the 3S5 or 3S6; a sampling time base such as the 3T5 or 3T6; and the Type 230 Digital Unit.

shift register

The principle part of a Type 240 is the Shift Register. The Shift Register of the 240 utilizes a serial-parallel four bit character format. That is, each cell of the Shift Register holds four bits at a time and thus may be said to contain one character. Since the Shift Register is 48 characters long, the total word length for a 240 is 48 four bit characters. The word length may be expanded in increments of 48 characters for each (limit two) additional Type 250 Auxiliary Program Control instrument.

type 250

The Type 250 will not operate by itself but must be operated as an auxiliary to a Type 240. The principle purpose of the Type 250 is to expand the number of cells present in the Shift Register. With a Type 240 and one 250 the word length is 96 four bit characters. With a 240 and two 250's the word length becomes 144 four bit characters. The Type 240 by itself provides programming for the sampling units and the digital unit. If additional devices are to be programmed such as pulse generators, power supplies, etc., the Type 250 is required.

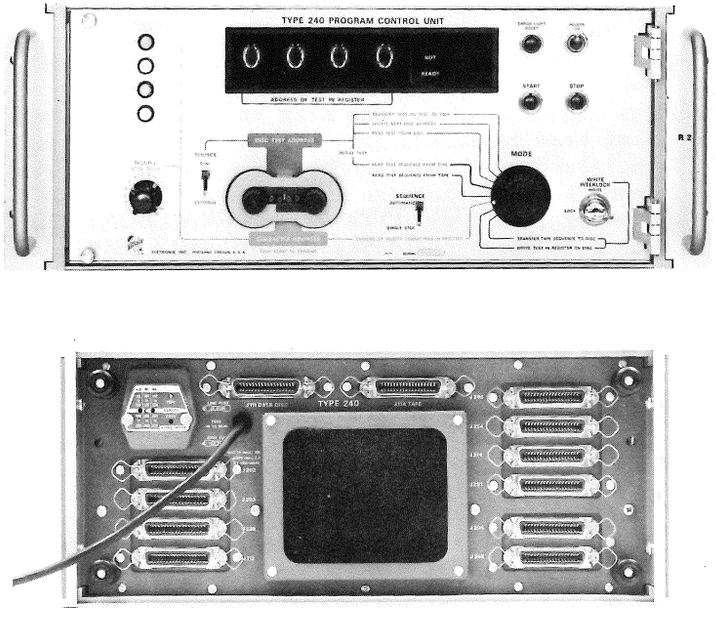


Fig. 4-1. Type 240 front and rear views.

The Type 240 accepts program data in serial by bit form from the rotating disc memory and serial by character form from a punched tape reader or computer. The front panel of the Type 240 is shown in Fig. 4-1. There are 8 modes of operation which will be discussed in detail.

read test sequence from disc

The mode which is probably most commonly used is the READ TEST SEQUENCE FROM DISC. In this mode the sequence of operation is as follows: The Type 240 first requires the initial Disc Test Address. This may be given to the Type 240 via the four dial switches labeled DISC TEST ADDRESS or may be supplied to the Type 240 from an external source via a plug on the rear. The address consists of four decimal digits with the following format: The first digit of the address identifies the head in the Rotating Disc unit



four bits

which is to be turned on. The head numbers assigned range from 0 to 7 for the 8 heads in the disc memory. The 8th head is not called number 8 because the address in the 240 is in binary coded form which requires four bits to express the digit 8 and only three bits to express digits between 0 and 7. By using numbers 0 to 7 for the 8 heads a bit may be saved for other purposes. The last three digits of the address determine the sector which is to be read by the 240.

Recall that on the rotating disc memory each track contains 200 sectors. Suppose address 7010 is selected. The Type 240 generates the Head Change pulse and the Track Selection lines are energized. Head number 7 is selected. Then sector pulses are counted until the sector 10 pulse appears. At that time the Load line goes true and serial data from the disc is loaded into the Shift Register. Refer to the simplified block diagram in Fig. 4-2. (In the following block diagram discussions, detailed block diagrams are not used. Only the most important signals or line connections will be mentioned. For a detailed discussion of the Type 240 refer to the Type 240 instrument manual.)

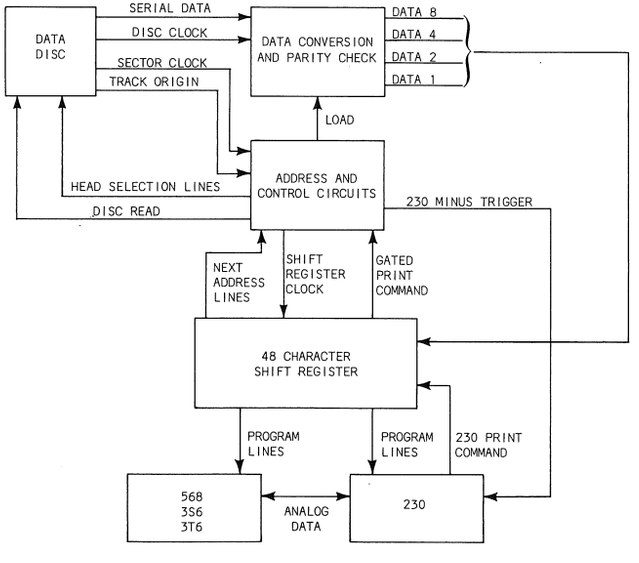


Fig. 4-2. 240 block diagram--read test sequence from disc mode.

serial to parallel conversion

Recall that data is stored in the disc in serial form, four bits of data plus a fifth bit for parity; followed by four bits of data plus a fifth bit for parity, and so on. The format of the Shift Register in the Type 240 requires that data be entered one character at a time in four bit parallel form, therefore, a serial to parallel conversion is required. This conversion takes the first four bits of each character and places them on four parallel lines labeled Data 8, Data 4, Data 2 and Data 1. At the time the fifth bit arrives parity is checked. The Data Conversion and Parity check section must find that the total is an even number.

error in loading

If at any time during the load process an error is detected, a special routine is initiated which repeats the entire sequence. That is, the 240 goes back to the beginning, counts sector pulses all over again and reinitiates the Load cycle from the beginning. The Type 240 will continue to repeat this process if an error continues to occur until stopped by the operator by means of the STOP push button on the front panel of the Type 240.

loading shift register

With the arrival of the parity bit, all four bits of the character are available on the four parallel lines. At this time after parity check has occurred, the first character is shifted into the Shift Register. The Shift Register is called a "left shift register" because on the block diagram or schematic the data appears to move from right to left. After shifting the first character into the Shift Register the Data Converter immediately begins to convert the next four bits into parallel data. With the arrival of the second parity bit the second character is shifted into the Shift Register and so forth.

character counting

In the Address Counter and Control Circuitry block an additional counter is included called the Character Counter. After 48 shifts have been made into the Shift Register the Character Counter will signal that registers are full. At this time the Load signal will end. The Shift Register contains 48 characters or 192 bits of data. Next, the output of each cell of the register is made available on a parallel basis. 192 lines are present each of which contains either a 1 or 0. A number of these lines connect to the sampling vertical plug-in, a number connect to the sampling time base plug-in



program application

and a number to the Type 230 Digital Unit. The program lines set vertical sensitivity and vertical offset in the sampling vertical, equivalent time per centimeter and delay in the time base and tell the Type 230 what kind of measurement is to be made. The Type 230 uses up to a total of 105 lines. With the program made available to the Type 230 and the plug-ins the system is now ready to make the measurement.

measurement sequence

To initiate the measurement the Control Circuit part of the 240 initiates a pulse called the "230-Trigger." This connects to the 230. The 230 proceeds through its operating cycle making either the time or voltage measurement as programmed. When the measurement is completed the Type 230 puts out a signal known as "230 Print Command." The Print Command signal couples back to the 240 Shift Register. From the Shift Register a signal called "Gated Print Command" goes back to the Control Circuit.

new load cycle

When the Gated Print Command arrives at the Control Circuit block an entirely new Load cycle is started. This time however, instead of locating the address which was placed in by the DISC TEST ADDRESS dials on the front panel of the 240 the Control Circuit box connects to characters 4, 5 and 6 of the Shift Register. In each sector loaded from the disc the first three characters of information always give an identifying number for that particular measurement. Thus at the present time since the first cycle was addressed 7010 the first three characters of information in the Shift Register contain Present Address. Characters 4, 5 and 6 always contain Next Address, this is to say, at the system programmers option characters 4, 5 and 6 may be set to direct the 240 to go next to any of the 1,600 sectors available on the disc.

character format

A special format is used in the Present Address block of characters and the Next Address block of characters. Fig. 4-3 is a program format for those characters. Examine particularly character 1. Bits 4, 2 and 1 always contain the head or track number upon which this sector is located on the disc. Here we see in bit cells 4, 2 and 1 the bits, 1, 1, 1. Binary 1, 1, 1 is decimal 7. Thus these bits identify the address as being on track 7. Bit 8 of character 1 is part of the sector identifying number. If bit 8 is a 0 the second digit of the address is 0. Thus by the special format of character 1 two decimal digits are indicated. Because of the special way of numbering sectors the second digit of a sector is always either a 0 or a 1. This explains why no sector is numbered 200 because to express 200 would require another bit. In this case bit 8 of character 1 is a 0 so we have as the first two digits of our address 70. Character 2 contains the third significant digit of the address in BCD format. In this case we see the binary digits 0001 which in BCD# is decimal 1. In the third character we see the last significant figure of the address in BCD form which is 0. Thus the complete address read from left to right is 7010.

next address

At the time the Shift Register is loaded, the twelve bit cells which contain the first three characters of data are connected through suitable circuitry to the NIXIE* tubes on the front panel of the Type 240. The Nixie tubes then display the present address in proper format. The operator is always informed of the address number of the sector which is stored in the register. Characters 4, 5 and 6 always contain Next Address. The format for characters 4, 5 and 6 is similar to that of characters 1, 2 and 3. That is, bits 4, 2 and 1 of character 4 contain the track number for the next address. In this case we see 1, 1, 1 which is decimal 7, the first digit of the next address is a 7. Looking at bit 8 we see a 1, therefore, the first two digits are 71. Character 5 in BCD contains a 2. Character 6 contains a 2. Thus, the four digit address is 7122. The twelve bits from characters 4, 5 and 6 are made available to the Address Counter and Control Circuit block. Since we are operating in READ TEST SEQUENCE FROM DISC, the next test which is to be performed in the sequence is located at address 7122.

#See Digital Concepts Book, Tektronix, December 1968, Page 7.

*Registered Trademark - Burroughs Corporation.



next sequence

230 Print Command has been received from the 230 indicating that a measurement has been completed. The 240 is now ready to perform a new cycle. The Control Circuit now connects to characters 4, 5 and 6 of the Shift Register. The Next Address contained here is used by the Address Counter and Control Circuit block to locate the next measurement. The head selection line again selects head 7. This time the Load signal activates at sector 122. Load causes the Data Conversion block to begin to load data from the Data Disc to the Shift Register. Each new character is shifted until the Character Counter in the Control Circuit block indicates that 48 characters have been shifted. Now the Shift Register is signaled to connect the 192 lines to the system. The sampling plug-ins and the Type 230 receive the new program. A new Type 230 trigger signal is generated. The Type 230 performs the function and sends back 230 Print Command to the 240 Shift Register. The Shift Register sends the Gated Print Command to the Control Circuit block which enables a complete new cycle. Thus the sequence will continue automatically.

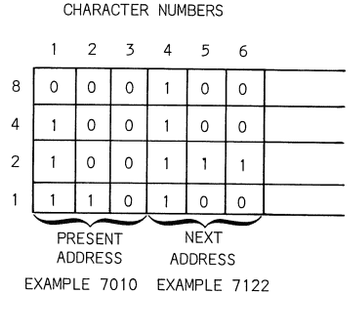


Fig. 4-3. Format of characters 1-6.

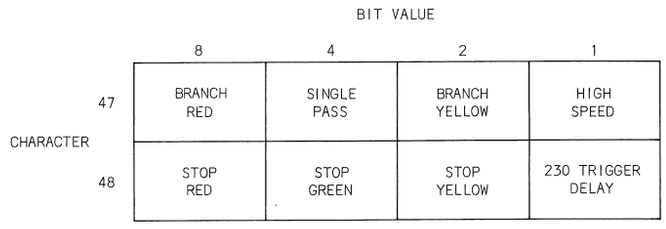


Fig. 4-4. Format of characters 47 and 48.

The cycle continues until a measurement is loaded which contains special data in character 47 or 48. Refer to Fig. 4-4 which shows the character format for characters 47 and 48 of the Type 240. In character 48 bit 8 is labeled Stop Red, bit 4 is labeled Stop Green, bit 2 is labeled Stop Yellow. At the programmer's option within a measurement sequence should the device being tested fail any one of the measurements the sequence may be stopped at that point. Should the 230 when comparing its limits against the measured results indicate that the device is either ABOVE UPPER LIMIT (Red light) or BELOW LOWER LIMIT (Yellow light) the programmer may cause the sequence to stop at that point by simply making bit 2 or bit 8 of character 48 true. The Type 240 then stops the sequence on any measurement which ends with a Red or Yellow lamp illuminated. In order to unconditionally stop the sequence the programmer goes to character 48 and makes bit 8, bit 4 and bit 2 all true. At least one of the three indicator lights on the front panel of the Type 230 will always light at the end of a test. By programming Stop Red, Stop Green and Stop Yellow the sequence must stop at this test. Thus the programmer has complete control over the stop point for a sequence. A sequence might be a total of two measurements, four measurements or fifty-nine measurements at the option of the programmer.

program options

The other bit cells in characters 47 and 48 provide various program options for a measurement sequence. Character 48 bit 1 is the 230 Trigger Delay bit. If that bit is made true the 230 trigger signal will be delayed by an amount which is manually adjustable between 25 ms and 250 ms. In a large system



containing DC power supplies and pulse generators often a certain amount of settling time is required. For example, the Type R116 Programmable Pulse Generator, when changing from one range to another, may require up to 50 to 100 ms for the circuits to seek the new programmed levels and for transients to settle down. For a measurement which involves such a change in the R116 the programmer may introduce a fixed amount of delay to allow for that settling time. If the Type R116 requires 100 ms settling time for a certain range change, by delaying the 230 trigger by 150 ms ample time is allowed for the R116 to reach its new setting and settle down before the 230 is triggered to make a measurement.

Character 47 bit 1 is called a High Speed bit. When character 47 bit 1 is made true certain functions are enabled in the Type 230 which will speed up the total measurement time. The effects of the High Speed bit are discussed in detail in Chapter 8.

repeat measurement

The Type 240 is automatically programmed to repeat any measurement which gives an out of tolerance indication. This is to say, for a particular measurement, if the 230 Front Panel Red light comes on the 240 will detect this condition and automatically repeat that same measurement. In a sense the 240 is saying to the 230: "Are you sure the device is out of tolerance?" On the second pass or second measurement the 240 will proceed as normally, that is, with the arrival of the second 230 Print Command the Type 240 will go on to the next measurement in the sequence. Should the programmer desire to save time by avoiding the double pass feature, with character 47 bit 4 made true the 240 will only make a single pass on a measurement which results in a Red or Yellow limit indication.

240 decision making

Character 47 bit 8 and bit 2 provide the system programmer with a powerful programming tool. At the option of the programmer, the Type 240 may be given a limited form of decision making capability by means of these bits. Suppose that at test 10 of a sequence the risetime of the device (a transistor) being tested by the system is measured. If the transistor has a faster than normal risetime, it may become a premium quality transistor which requires a different series of tests. A programmer at test 10 character 47 bit 2 true may enable the Branch Yellow sequence. In this case, if at test 10 of the normal

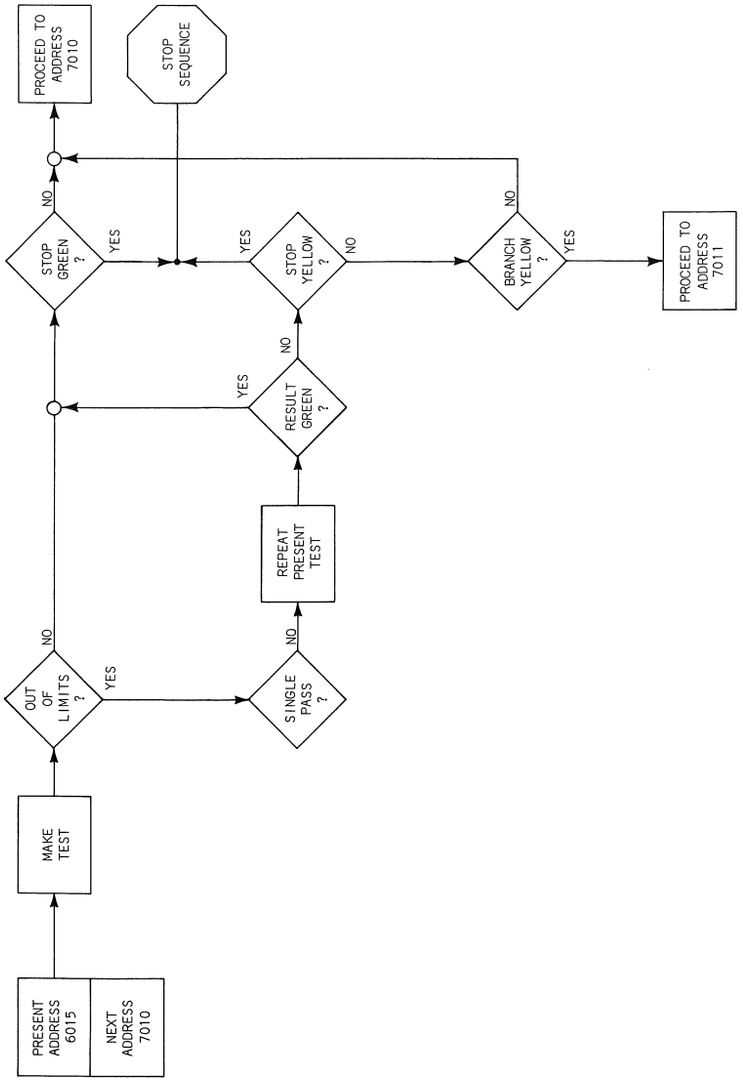


Fig. 4-5. Partial double pass and branching flow diagram.



sequence the transistor gives results which cause the BELOW LOWER LIMIT light to come on, circuitry in the Type 240 will detect the presence of the Yellow light and will initiate a branch sequence in the program.

branching

When branching is energized a special process takes place within character 6. Recall that character 6 is the least significant digit for Next Address. The branching circuitry will connect to bit 1 of character 6 and add 1 to that bit, in other words, when a branch sequence is enabled the branch circuitry automatically alters Next Address in the sequence. *This requires that the measurement in a test sequence where branching is desired must have an even numbered Next Address.* To be effective bit 1 of character 6 must be a zero. No carry circuitry is present in the Type 240, if bit 1 of character 6 is already 1, adding a 1 will produce no change.

branching sequence

The preceding relationships are quite complex. The sequence of events may be understood more clearly by the use of a flow diagram. See Fig. 4-5. We assume the present test in a sequence is address 6015. When the test has been made a number of questions are asked by the decision making circuitry in the Type 240. The first question asked is: "Is the measurement Out Of Limits?" If the answer is no, then the next question asked: "Is Stop Green energized?" If the answer is again no, the 240 will proceed to the next address (For this example 7010). If the result of the out of limits question is yes, an alternate question becomes appropriate: "Is Single Pass energized?" If the answer is no, the present test will be repeated. After the test the question: "Is the Result Green?" will be asked. If the answer is yes, we proceed back into the normal sequence. "Is the Stop Green energized?" If no, then the 240 proceeds to address 7010. If Single Pass is energized the sequence will bypass the Repeat Test sequence and will proceed to the question: "Is Stop Yellow energized?" For the present sequence we assume that the result of the test was below limits, therefore the yellow light is on and that after repeating the test the yellow light is still on. Therefore, after the Result Green question is asked, the answer is no. Next the circuitry which asks "Is Stop Yellow energized?" comes into play. If Stop

Yellow is energized then the 240 will proceed to stop the sequence. If the answer is no the Branch Yellow circuitry will come into play. Is Branch Yellow energized? If the answer is no, we proceed immediately to next address 7010. If the answer is yes, we proceed to address 7011. Notice that the previously mentioned circuitry will have changed bit 1 of character 6 (the last digit of Next Address) from 0 to 1.

programmer option

The programmer at his option from address 7011 may proceed into an entirely new sequence of measurements which could perhaps measure the device against a set of tighter limits. Those which successfully passed the tighter limits sequence could be premium quality devices. The measurement at test 6015 could have resulted in a Red ABOVE UPPER LIMIT indication. In this case the risetime would be lower than normal. An alternate branch routine could be incorporated at this point to check the device against relaxed limits.

A complete flow diagram including the Branch Red and Branch Yellow options is shown in Fig. 4-6. It is clear at this point that the 240 may be programmed to perform a limited type of decision making. This may be compared to the decision making capability of a computer.

Once branching has taken place the 240 will be in an entirely new sequence. The programmer could, should he so desire, initiate new branching decisions within each new sequence. The complexity of the possible testing procedure for a single device is limited only by the maximum number of measurements which are available on the rotating disc memory. With a grand total of 1,600 measurements available very complex test routines can be set up in the system.



read test from disc

Another mode of operation for the 240 is READ TEST FROM DISC. The READ TEST FROM DISC mode is quite similar to the READ TEST SEQUENCE FROM DISC mode. The difference being that the 240 will go to the Disc Test Address set in by the dial, or the external source, load that test, make the measurement and stop at that point. The sequencing circuitry is disabled. Using this mode to proceed from one test to another test the Type 240 must receive a change in disc test address either by manually changing the front panel dials or changing the external source address. In this mode, if a parity error is detected, no repeat search is made. The 240 simply completes the load sequence. This permits examining the Shift Register bits to determine what the error is.

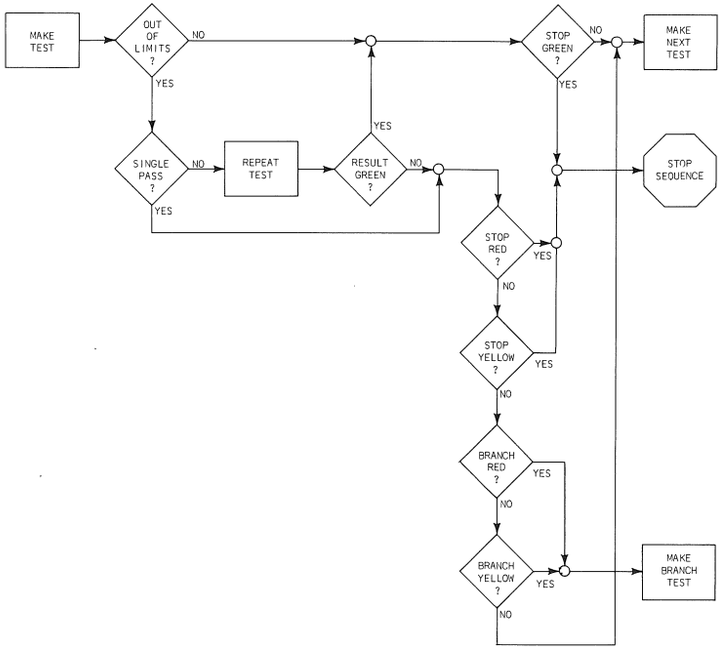


Fig. 4-6. 240 branching flow diagram.

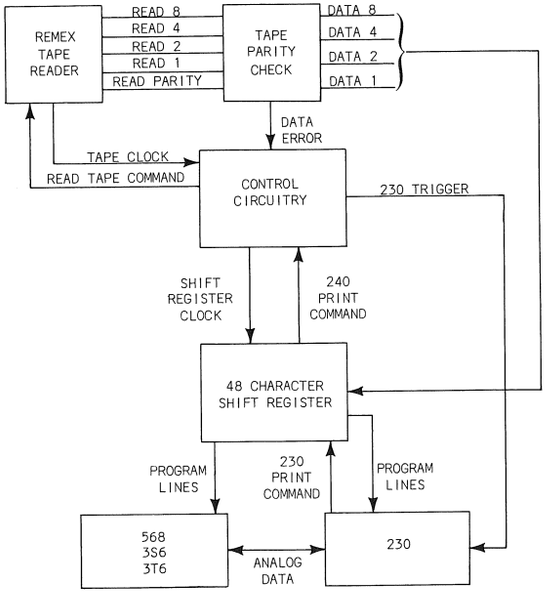


Fig. 4-7. 240 block diagram--read test sequence from tape mode.

read test sequence from tape

A third mode of operation is READ TEST SEQUENCE FROM TAPE. When the system utilizes only the punched tape as a memory or when it is desired to operate alternately between the rotating disc memory and the tape memory the READ TEST SEQUENCE FROM TAPE mode is chosen. A block diagram of the 240 operating in READ TEST SEQUENCE FROM TAPE mode is shown in Fig. 4-7. Data from the tape reader comes via five parallel lines: the Read 8, Read 4, Read 2, Read 1 and Read Parity lines. Since the data is already in character format no serial to parallel conversion need take place, therefore, the data enters the Tape Parity Check block, is checked for parity and is then shifted directly into the Shift Register. Again the Control Circuit counts the number of times a character has been shifted into the Shift Register and in the case of a single 240 ends the Read Tape Command at the 48th character. The Tape Clock signal provides the necessary timing signals for Shift Register clocking.



Should the Tape Parity Check block detect an error, most probably the tape has been mispunched. The Remex Tape Reader is a unidirectional device so when a Tape Parity error is detected the only thing that can be done is to stop it. The only way of reloading the test is to physically remove and reinsert the tape and start over again.

Once the Shift Register is completely filled it is signaled to make its data available. The 230 makes the new measurement, sends 230 Print Command back to the Shift Register of the 240. If the measurement is out of limits the 240 checks for single pass or double pass. If it is programmed for double pass the measurement is made again. The second time 230 Print Command arrives at the Shift Register the Gated Print Command is generated and sent to the Control block. The Read Tape Command then allows the system to load the next measurement. This will continue until a test occurs which has character 48 set for Stop Red, Stop Green and Stop Yellow. With the end of a sequence the tape must either be physically repositioned to the beginning measurement or the tape may be operated in an endless loop fashion. If the tape is looped the entire sequence may be repeated again by pushing the START button on the Type 240 front panel.

transfer test on disc to tape

Another mode of operation for the Type 240 is the TRANSFER TEST ON DISC TO TAPE mode. Even though a disc may contain up to 1,600 measurements it is quite possible that a single disc may not be able to hold enough single programs to enable the tests of all varieties of devices that the system operator wishes to make. It is possible by utilizing the tape perforator to transfer all of the tests on a disc to a permanent record on a punched tape. The system owner may also make a permanent copy (hardcopy) of all data on the disc as insurance against the possibility of accidental erasure of data on the disc.

In the present mode the operator may transfer each Disc Test Address to the tape in the following manner: Set the address using the DISC TEST ADDRESS dials. Next push the START button. At this time the 240 locates the desired Disc Test Address and loads the address into the Shift Register. When the Shift Register is full, the Type 240

automatically transfers the data in the registers to the tape perforator which in turn punches the tape in the required character format. The 240 contains circuitry which automatically generates a parity bit for each character. For each test which is to be transferred to tape the above procedure applies.

examine or modify characters in register

The 240 permits a complete program to be built directly in the Shift Register. An operator, from the front panel of the Type 240, can completely program each bit and each character in the Shift Register. The mode which makes this possible is the EXAMINE OR MODIFY CHARACTERS IN REGISTER mode. On the front panel the lettering for this mode is in green and utilizes the same dial which is called DISC TEST ADDRESS in the various DISC modes. The three right hand digits of the dial are labeled in green as CHARACTER ADDRESS. The output end of the Shift Register is connected back to its input end forming a Circulating Shift Register. When the START button is pressed the Type 240 refers to the CHARACTER ADDRESS dials, interprets that number and initiates a shift cycle around the Shift Register loop.

For example, suppose the dials are set for character 10. When the START button is pushed the Shift Register receives clock pulses which shift the data in the registers in an endless loop. If a Type 240 is used without a Type 250, the register will be shifted exactly 48 times. The character counter in Control Circuit will count each shift pulse and when the total reaches 48 the data which was originally in character 1 will have been shifted back to its original position. All other characters will be back in their same respective positions. When the 10th shift pulse is applied to the Shift Register the data stored in character 10 is just shifting out the end of the Shift Register. At this time a four bit storage register is energized which stores the data in character 10. To give the operator a visual indication of what was stored in the particular character in question, four lamps appear on the 240 front panel, labeled CHARACTER DATA 8, 4, 2 and 1. The lamps connect to the four bit storage register. Should character 10 contain 0101 the 4 light and the 1 light will be illuminated. To interpret the data of the character a light which is not illuminated counts as a 0 and an illuminated light counts as a 1.



modify new data

Just below the CHARACTER DATA lights is a concentric rotary switch-push button arrangement labeled MODIFY-NEW DATA. The rotary switch has 16 positions labeled from 0 to 15. Using our previous example, supposing character 10 has 0101 stored in it and we wish to change the data stored in that character to 1101. The value of 1101 in binary form is 13 in decimal form. The 16 position switch is rotated until the indicator points to 13 and the red NEW DATA button is depressed. At that time the Shift Register will again perform 1 complete revolution. This time however, when character 10 (we still assume the CHARACTER ADDRESS dials are set for character 10) arrives at the output the data presently stored in character 10 is discarded and the new data bits 1101 are inserted. The shift cycle continues for 48 clock pulses, at the end of the cycle character 10 is back in its original position in the Shift Register. The only change is that instead of reading 0101 as before character 10 will read 1101.

Utilizing the EXAMINE MODIFY mode and the MODIFY-NEW DATA switches all 48 characters in the Shift Register may be loaded to any desired program. Hand loading a complete program can be time consuming. Very often however only one or two characters (of the 48 total) need be changed from one measurement to the next. The operator therefore can modify the required characters and store the complete contents of the Shift Register on the disc. This means that a long measurement sequence can be stored on the disc within a reasonably short time.

modify disc data

When the operator desires to modify an existing program on the disc the procedure is quite simple. Suppose that the operator desires to change the test stored in address 6111. He places the MODE switch in the READ TEST FROM DISC mode, places the DISC TEST ADDRESS switches to read 6111 and pushes the START button. This loads the Storage Register with the complete program stored in address 6111. He then switches to EXAMINE OR MODIFY CHARACTERS IN REGISTER mode and by selecting the desired character for example, character 25, and pushing the START button he can examine the present data in that character. Should he desire to make a modification he rotates the MODIFY switch to the proper position presses the red concentric NEW DATA button and the

data in character 25 of the register is now modified. It is important to notice at this point that the bits stored in character 25 of the *register* have been modified. Character 25 stored on the disc has *not* been modified. In order to make that modification another mode of the Type 240 is used.

write test in register on disc

This is WRITE TEST IN REGISTER ON DISC. Having examined and modified the test taken from 6111 to the operator's satisfaction the operator next rotates the MODE switch to WRITE TEST IN REGISTER ON DISC mode and pushes the START button. At this time the Type 240 locates the address listed in characters 1, 2 and 3 of the register (in this case address 6111), energizes head 6, counts Sector Clock pulses until the 111th pulse arrives. It then shifts the data from the Shift Register to the Data Disc through the Disc Write circuitry of the Data Disc mechanism. This will rewrite that sector of track 6. This is the only way the original information on the disc may be modified. The original modification in the Shift Register is not enough.

To prevent accidental modification of data which is stored on the disc a WRITE INTERLOCK switch has been placed on the front panel of the Type 240 which contains a key. If the key is not inserted and rotated, turning the MODE switch to WRITE TEST IN REGISTER ON DISC will have no effect. The key must be installed and rotated to the WRITE position in order to change stored data on the disc.

transfer tape sequence to disc

Another mode is called TRANSFER TAPE SEQUENCE TO DISC. This mode will be used when a complete test series has been prepared by punching the measurements on a punched tape. In this mode when the START button is pressed, the 240 first energizes the Remex Tape Reader and loads the first measurement into the Shift Register. When loading is completed, (after 48 characters for a single 240) the Type 240 automatically switches to the WRITE TEST IN REGISTER ON DISC mode and transfers the information in the Shift Register to the disc. The tests on the punch tape must contain the address information, that is, characters 1, 2 and 3 must contain Present Address, characters 4, 5 and 6 must contain Next Address.



The Type 240 when transferring the information that is in the Shift Register to the disc will utilize the first three characters of the measurement to determine what sector of what track in which to write the data. After the information has been transferred to the disc the Type 240 again signals the tape reader to clock in the next measurement sequence. When the Shift Register is loaded the data is shifted to the proper sector of the proper track of the disc. This continues until the tape reader either runs out of tape or no more data appears on the tape.

This last mode along with the TRANSFER TEST ON DISC TO TAPE mode makes possible the storing of all test data in permanent or hard copy form. A disc could be accidentally erased, but unless a tape was physically destroyed, no information would be permanently lost. At any time information is improperly written on the disc or if an entirely new set of 1,600 measurements are desired to be loaded into the disc the TRANSFER TEST ON TAPE TO DISC mode will make possible the rewriting of the entire disc or any portion thereof.

The last mode of the Type 240 is the LOCATE NEXT DISC ADDRESS mode. This particular mode will only be utilized when the programmer desires to utilize the maximum measurement speed capabilities of the complete system. Recall the READ TEST SEQUENCE FROM DISC mode sequence. When a measurement presently stored in the Shift Register has been completed the Type 240 by referring to characters 4, 5 and 6 determines the new address. In order to locate the new address, the proper Head Selection signals and the Head Change pulse must be generated. The sector counter when not in a Load cycle is always reset by the Origin pulse and is continuously counting sectors. The Next Address number is presented to the sector counter enabling it to locate that sector.

locate next disc address

time saver

Suppose it were possible to determine the next most accessible sector after a measurement has been completed. Time could be saved by using that sector as the next address. The LOCATE NEXT DISC ADDRESS mode makes this possible. The advantage here would be that rather than having to wait for possibly one complete revolution of the disc to locate the next

sector, the Type 240 may be able to load the next most accessible sector directly into the registers without having to wait. Recall that the disc revolves at the rate of 1,800 revolutions per minute. This makes 30 revolutions per second, therefore a complete revolution takes 1/30 of a second or about 33 milliseconds. This rotation time if added to measurement time unnecessarily limits the measurements per second rate of the system.

As an example, suppose that the present measurement appears on sector 1 of track 6. When the Load cycle begins, the registers are loaded in approximately 167 microseconds. After the registers are full, the Type 230 receives its trigger. The Type 230 may be able to complete its measurements in as little as 4 ms utilizing the high speed options. When the measurement is completed and the results are made available the disc will have revolved about 24 sectors. The next sector available after the measurement period is ended might be sector 80. If a means is provided to determine what the next most accessible sector is and the 240 is programmed in its Next Address characters (4, 5 and 6) to go to that sector, a considerable improvement in measurement speed can be obtained.

The operator first selects the Disc Test Address of interest by means of the front panel controls using READ TEST FROM DISC mode. Placing the mode switch in LOCATE NEXT DISC ADDRESS position and SEQUENCE at AUTOMATIC he presses the START button. The Type 240 locates the required disc address and loads that test in the registers. When the registers are loaded the system is signaled to perform the measurement called out in that sector. When Gated Print Command is received back from the measurement portion of the system, the Type 240 immediately causes the Read Disc Command line to go low and the next sector just going by the heads is loaded into the registers. That sector, whatever it is, contains its address in the first three characters. The Nixie tubes immediately display that address. In this special mode however, the left most Nixie which usually displays the track number will remain at 0. This is to indicate to the operator that should sector 76 be the next most accessible sector after a measurement is completed, it makes no difference on which track sector 76 is used. He may choose

locating next address



sector 76 of any one of the 8 tracks as selection of a different head adds no time to the Load cycle.

Several other controls are present on the front panel of the Type 240 which have not been mentioned until now. Located to the left of the MODE switch is a lever switch labeled SEQUENCE with two positions - AUTOMATIC and SINGLE STEP. During setup procedure for a test sequence the MODE switch may be placed in the READ TEST SEQUENCE FROM DISC mode and the SEQUENCE switch placed in a SINGLE STEP position. In this case the operator may go through a complete Read Test Sequence From Disc series one step at a time, that is, with the MODE switch in READ TEST SEQUENCE FROM DISC and the START button pressed, the 240 locates the first address of the sequence by means of the DISC TEST ADDRESS dials. It loads that address and stops. When the START button is pressed again the 240 refers to characters 4, 5 and 6, goes to that address, loads that address and stops again and so on. The operator may check out his sequence series one step at a time. In the normal routine of operation the sequence progresses so rapidly the operator may be unaware that the sequence is improperly programmed so as to skip a measurement.

sequence switch

A number of lights are mounted behind the front panel which display certain signs - SEARCH, NOT, READY, DISC ERROR and DATA ERROR. The READY sign is displayed whenever the registers are loaded and the 240 is ready for a cycle. Should the START button be pressed in a particular mode and the 240 not be ready to do that particular job a NOT sign will appear immediately above the READY sign informing the operator that the 240 is not ready to do the desired function.

An example of this, suppose the operator desires to operate in the WRITE TEST IN REGISTER ON DISC mode but has not placed the WRITE INTERLOCK switch in the WRITE position. Either the key is not installed or the key is in the LOCK position. In this case, when the START button is pressed the NOT READY sign will come on indicating that the 240 is not in a condition to WRITE TEST IN REGISTER ON DISC. By putting the WRITE INTERLOCK switch in the WRITE mode and again pressing the START button the READY sign will flicker and the NOT sign will not

ready, not ready sign

be displayed. This indicates that the function has been performed. In the normal sequence of operation, for example, when using READ TEST FROM DISC MODE, when the operator presses the START button the READY sign goes out and the SEARCH sign comes on. The normal Load cycle is so short that for all practical purposes the READY sign is seen to blink and the normal thermal inertia of the lamps is such that the SEARCH sign is never seen to come on. However, should something be wrong and the 240 be unable to locate the proper address the READY sign goes out and the SEARCH sign comes on and remains on. This signals the operator that the 240 is in a SEARCH mode but is unable to locate the proper address.

In order to take the 240 out of the Search mode a push button labeled STOP is located on the front panel of the 240 to the right of the START button. If for any reason the 240 is not able to complete its cycle and remains in SEARCH, pressing the STOP button will in most cases restore the 240 to the READY condition. STOP cancels the START button.

error sign

There are two error signs. One is labeled DISC ERROR. Should an error occur in loading a measurement from the disc the DISC ERROR sign comes on. Should a parity error whether from tape or disc be detected another sign comes on labeled DATA ERROR. When either one of the signs comes on it remains on. That is, each is driven by means of a FF which is set by the presence of an error signal. The FFs will remain in the set condition (with the sign on) indefinitely until the operator pushes the ERROR LIGHT RESET button on the front panel.

checking signs

The fact that a DISC ERROR or DATA ERROR sign is on is no indication that the 240 is not operating properly. The operator may determine whether or not the system is operating properly by looking at the SEARCH and READY signs. For example, suppose the DATA ERROR and READY signs are on. This means that at some time in its cycling the 240 has encountered a data error. If operating in the READ TEST SEQUENCE FROM DISC mode, recall that when a disc error is detected the Load cycle is automatically repeated. In effect the 240 is told to try again and it keeps trying until it has loaded the address into its Shift Registers with no errors. As far as the ERROR sign is concerned it will remain on indefinitely. The operator may determine whether the



240 is operating normally or not by checking for the presence of the READY sign. If either of the ERROR signs is on and the 240 is in the READY condition, the test was successfully completed.

If, on the other hand, the SEARCH sign remains on, then the 240 is locked up in a SEARCH cycle. The operator may make an additional check by pressing the ERROR LIGHT RESET button. This applies a reset signal to the FFs which drive both DATA ERROR and DISC ERROR lights. If the error is not repeating the lights remain out, however, if the 240 is in a continuous SEARCH cycle it is receiving an error each time it attempts to load and the ERROR signs come back on. Rotating the MODE switch or changing the SEQUENCE switch also resets the ERROR signs.

type R250

The Type R250 Auxiliary Program Control Unit is nearly identical to the Type 240, that is, it contains identical Shift Register and Interface cards. The only thing lacking from the R250 is the Control Circuitry and Nixie indicators that the 240 contains. The purpose of the Type R250 is to provide an additional 48 characters of Shift Register capacity. The 240 may be operated by itself with one R250 or with two R250's. Recall that in the case of a 240 with two R250's the disc, because of the longer sectors required, will contain only 135 sectors per track. In this case, the total number of measurements which may be stored on a disc is 1,080. A complex system utilizing several pulse generators and a number of DC power supplies as well as complex matrixing facilities in the fixture area may require in excess of 500 program lines. Since a 240 contains 192 program lines and an R250 an additional 192 program lines a complex system may require a Type 240 and two Type R250's for a total of 576 lines.