IBM

Transistor Calculator

TYPE

608

MANUAL OF OPERATION—PRELIMINARY EDITION

Form 22-6666-0

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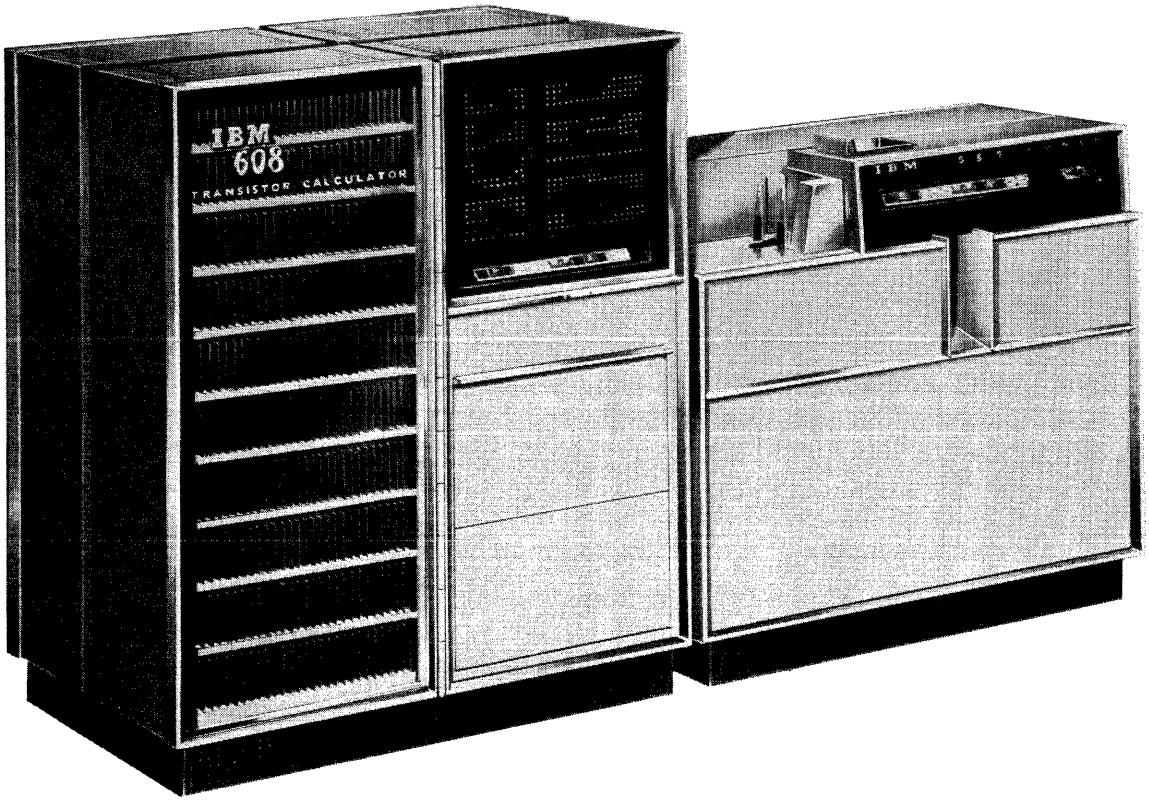


IBM 608 TRANSISTOR CALCULATOR

TRANSISTOR CALCULATOR

Type 608

THE TYPE 608 Transistor Calculator combines the latest advances in electronics. It uses transistors, magnetic core memory and printed card circuitry to perform all of the mathematical functions of addition, subtraction, multiplication and division at over twice the speed of the 607 Electronic Calculator. The high input-output speed of 155 cards per minute offered by the Type 535 Punch Unit further broadens the scope of the Transistor Calculator in the fields of data reduction, automatic control, general engineering and commercial data processing.

The 608 operates on transistors—tiny germanium devices no bigger than a paper clip—without the use of a single vacuum tube. Magnetic cores, which will not clear on a normal power shut-down, make up the "memory" of the machine. This is the first known use of transistors and cores together in a commercial computer. The use of these components saves valuable office space by making a 50 percent reduction in computer unit size. Power requirements and heat are reduced 90 per cent over a comparable vacuum tube model.

The flexibility of the 608 is greatly increased by the use of these new features:

Non-sequential Programming allows the program steps to be used in any sequence without loss of time for skipping unused steps.

Non-destructive Zero Test allows for testing of zero or non-zero condition of the accumulator without changing the value of the figure in the accumulator.

Coincidence Switches allow the checking for two simultaneous conditions.

Electronic Selectors allow the altering of programming during calculating time as a result of logical decisions.

Word Split. Each of the forty 9-digit words may be split into 3- and 6-digit words with separate signs.

Reset Add and Reset Subtract. These two instructions eliminate the need of a separate program step to reset the accumulator prior to accumulation.

Zero Test on Accumulator Read-out provides automatic zero test on transfer to storage.

Test Indication One and Two permit punch control and signal indication from any signal available on the calculator control panel.

Punch Start and Stop Keys permit control of the 535 punch unit from the 608 console.

Manual Storage Reset will clear all storage positions before the start of a job.

OPERATING PRINCIPLES

THE TRANSISTOR Calculator consists of two cable-connected units:

Type 535 Punch Unit
Type 608 Calculator Unit

The Type 535 operates at a speed of 155 cards per minute. Reading and punching of cards is done successively. As cards feed through the machine they pass three stations: an 80-column reading station, followed by the punching station, and last, another 80-column reading station. Factors read at the first station are transmitted to the calculating unit. As the card passes the punching station the calculated results are punched into the card. As the card passes the second reading station, it may be read for checking purposes.

The 608 calculator unit consists of four basic parts: the storage unit, the arithmetic unit, the shift control, and the program unit. It performs all calculations at the rate of .22 milliseconds for each addition or subtraction. The speed of multiplying or dividing is determined by the size of the multiplier or the quotient. The *maximum* time for multiplication is 19.8 milliseconds. The *maximum* time for division is 22.4 milliseconds.

The storage unit consists of 360 digits divided into forty 9-digit words. By means of control panel wiring, each 9-digit word may be split into two

words, each with its own sign. Thirty of the 9-digit word locations may be read into from the 535 and ten may be used to read out to punch. All storage words may be used during calculation. The word split assignment may be changed at any time during calculating to meet the requirements of the application.

All adding, subtracting, multiplying or dividing is done in the 18-position accumulator. Factors to be calculated are moved by program steps into and out of the accumulator and storage unit over a single 9-position channel. Each of the nine digits in a storage word is assigned to one of the nine positions in the common channel. When word split 7-9 is programmed, the three high-order digits of the storage word are placed on the three low-order channels. When word split 1-6 is programmed, only the six low-order digits of the storage word are allowed on the channel. When either word split is used, the remaining positions of the channel will automatically receive zeros.

The purpose of the shift unit is to allow a shift of the units position as many as nine positions to the left as a factor enters the accumulator. It also allows up to nine decimal positions to be dropped as a factor is transferred from the accumulator to storage.

The non-sequential program unit is used to advance the calculation from one step to another. These steps may be used in any sequence without loss of time for skipping unused steps. The sequence of these steps may be altered at any time during calculation, as a result of logical decisions, by use of the electronic selectors and coincidence switches.

Operating Keys and Lights, 535 Punch Unit

Main Line Switch. When this switch is turned on and the power-on key on the 608 console is depressed, power is supplied to the calculator and the punch. When the 535 is used for independent operation, power is supplied by this switch alone.

Start Key. Depressing this key feeds the cards and starts calculation.

Stop Key. Depressing this key stops the operation of the punch.

Reset Key. Depressing this key turns off any of the seven signal lights and allows the machine to be restarted.

Unlabeled Light. This light glows as soon as the main line switch is turned on. It turns off as cards pass through the machine and turns on again whenever the machine stops.

Fuse Light. This light goes on and the machine is stopped whenever a fuse burns out in the punch. When the fuse has been replaced, the light goes off and operations may be resumed by depressing the start key.

Field Overflow Light. This light turns on when the field overflow IN hubs are impulsed. The machine stops only if the field overflow OUT hubs are wired to a STOP hub.

Selected Stop Light. This light turns on when either of the SI hubs on the control panel is impulsed. The machine stops only if the SO hubs are wired to a STOP hub.

Double Punch Light. This light turns on whenever a double punch is sensed in one of the positions wired on the control panel. The machine will stop only if a STOP hub is wired to the DP hub.

Blank Column Light. This light turns on whenever a blank column is sensed in one of the positions wired on the control panel. The machine will stop only if a STOP hub is wired to the BC hub.

Unfinished Program Light. This light turns on, the machine stops, and all punching is suppressed whenever an unfinished program condition occurs.

Card Advance Light. This light turns on and the machine stops whenever a card fails to feed at any station in the punch.

Test Indication 1-2. These lights turn on whenever their corresponding IN hubs on the control panel are impulsed.

Operating Keys and Lights, 608 Calculator Unit

Power-On Key. Depressing this key turns on the power-on light and supplies power to the calculator. Power will also be supplied to the 535 punch unit if the main line switch is turned on.

Power-Off Key. Depressing this key stops the operation of the calculator and punch units, removes the power from the 608 calculator unit and turns off the power-on light.

Punch Start Key. Depressing this key starts card feeding in the punch unit.

Punch Stop Key. Depressing this key stops card feeding in the punch unit.

Storage Reset Key. Depressing this key resets the entire core memory to zero.

Program Test Key. Depressing this key once turns on the program test light and places the calculator unit under the control of either the program advance units key or the program select stop key. A second depression of this key returns the machine to normal operation.

Program Advance Units Key. Depressing this key, when the program test light is on, advances the program unit one step for each depression.

Program Select Stop Key. Depressing this key, when the program test light is on, initiates the normal high-speed operation of the calculator unit and makes the program stop hubs on the control panel active to accept test or program exit impulses. When the program stop hub is thus impulsed, calculation will be stopped at the end of the step on which the impulse was received. Depressing this key a second time will restart the above operation, beginning at the program step following the one on which the stop took place.

Display Key. Depressing this key, when the program test light is on, alters the function of the program advance units key so that it can be used to display selectively the contents of each storage word on the neon panel. The first word displayed will be word 1, and with each depression of the program advance units key, successive words will be displayed. Depressing the display key a second time returns the program advance units key to its normal function.

Power-On Light. This light turns on when the power-on key is depressed. It remains on until the power-off key is depressed.

Fuse Light. This light turns on and the machine stops whenever a DC fuse burns out in the calculator unit.

Program Test Light. This light turns on when the program test key is depressed once. It turns off when the key is depressed a second time.

Control Panel Light. This light turns on when the control panel is removed from either the 608 or the 535, any of the covers are opened on the 535, or if the power is turned off on the 535.

Storage Display Light. When on, this light indicates that the normal function of the program advance units key has been altered to allow the selective display of the storage word on the neon panel. This light is turned on by the first depression of the display key and turned off by the second depression.

CONTROL PANEL SUMMARY

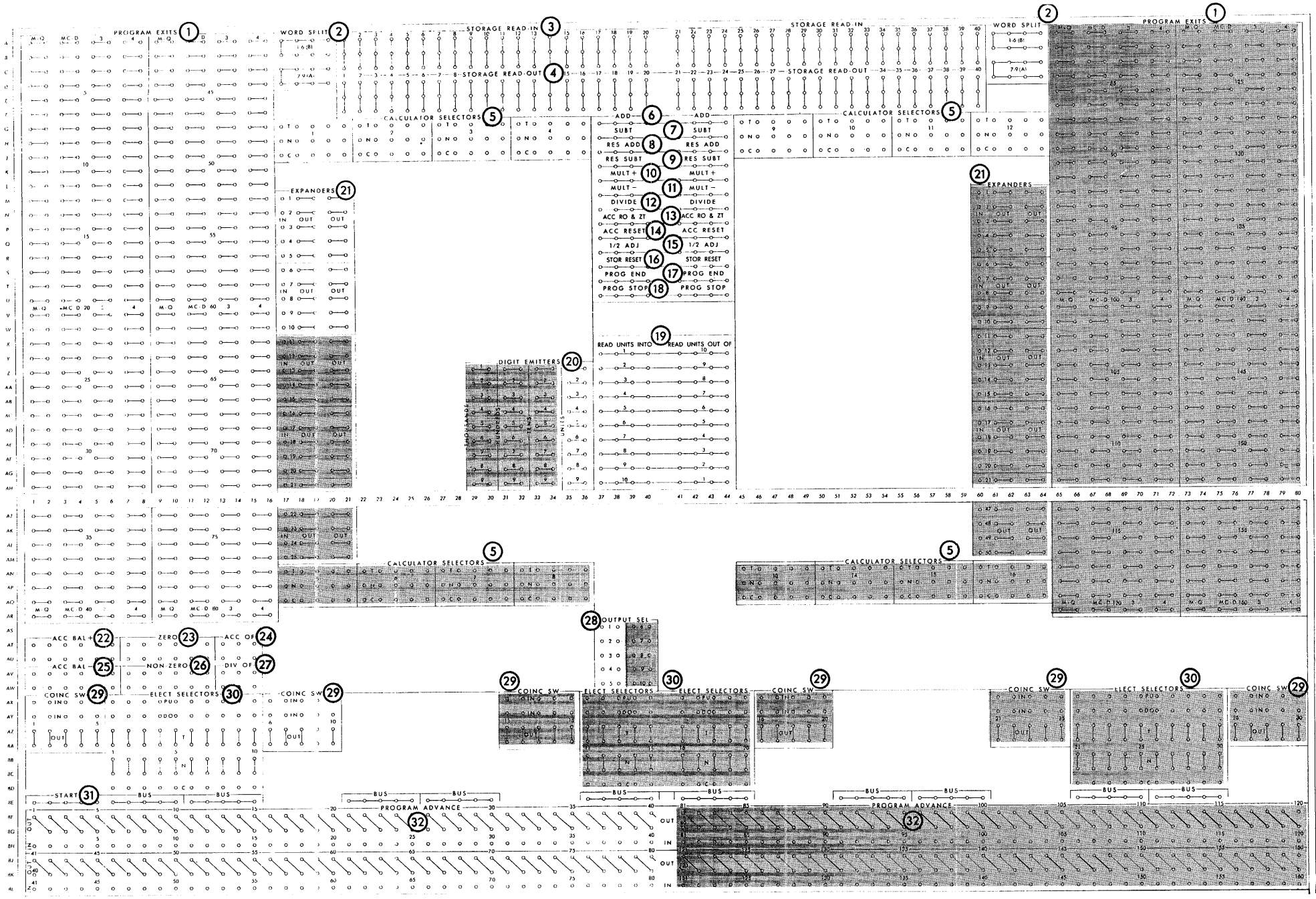
FUNCTIONS of the various control panel hubs are described in this section. The sections of the control panels are described in logical sequence. The number following each name refers to the corresponding number on the schematic diagram of the panel. On the illustrations, optional features are shaded.

Type 608 Control Panel

Start (31). One of these exit hubs is wired to any program advance IN hub to initiate the program sequence. After one card is read and before the next card is read, this hub emits an impulse to begin the calculation.

Program Advance IN and OUT (32). The IN hub is used to initiate a program step. It will accept an impulse from either the start hub or from the program advance OUT hub of the previous step used. The OUT hub emits an impulse at the end of the step on which the corresponding IN hub was impulsed. The program advance IN and OUT may be selected, thus altering the sequence of calculation.

Program Exits (1). These hubs emit an impulse as soon as their corresponding program drive IN hub receives an impulse. Each step has four independent outlets, each with two common hubs. These are wired to control the machine as it performs a specific part of a required calculation. When information is cross-footed or transferred from one storage unit to another, any of the four outlets may be used. When the operation is multiplication, the MQ hub must be wired to the read-out hub of the storage unit containing the multiplier. The MCD hub must be wired to the read-out hub of the storage unit containing the multiplicand. Both of the above must be on the same program step. In division, the MQ hub must be wired to the read-in hub of the storage unit where the quotient is to be developed. The MCD hub must be wired to the read-out hub of the storage unit containing the divisor. Both must be done on the same



608 Control Panel

program step. The dividend is placed in the accumulator on a previous program step.

Storage Read-In (3). These hubs accept impulses from the program exits to cause any of the 40 storage words to accept information from the 9-position channel. These words clear automatically when impulsed to read in.

Storage Read-Out (4). These hubs accept impulses from the program exits to cause any of the 40 storage words to read out its contents onto the 9-position channel. These words do not clear on read-out unless storage reset is also wired on the same step.

Word Split, 1-6, 7-9 (2). These hubs accept impulses from the program exits. To read into or out of the six low-order positions of a storage word without affecting positions 7-9, word split 1-6 should be wired on the same program step as the storage word. To read into or out of the three high-order positions of a storage word without affecting positions 1-6, word split 7-9 should be wired on the same program step as the storage word. Whenever word split 7-9 is wired, the storage word will either receive its information from or transmit its information over the three low-order positions of the 9-position channel. In multiplication, to use the word split feature with either or both factors, it will be necessary to wire either the MQ and/or the MCD program exit hubs through a program expander to both the storage word and word split hubs. The same basic principle holds true in the case of division. If neither of the word split hubs is wired, all nine positions of the storage word will receive or transmit as indicated by control panel wiring.

Add (6). These hubs accept program exit impulses to cause the accumulator to add.

Subtract (7). These hubs accept program exit impulses to cause the accumulator to subtract.

Reset Add (8). These hubs accept program exit impulses which cause the accumulator to reset to zero before the factor is added.

Reset Subtract (9). These hubs accept program exit impulses which cause the accumulator to reset to zero before the factor is subtracted.

Multiply + (10). These hubs accept program exit impulses to cause the machine to multiply on a positive basis.

Multiply — (11). These hubs accept program exit impulses to cause the machine to multiply on a negative basis.

Divide (12). These hubs accept program exit impulses to cause the machine to divide.

Accumulator Read-out and Zero Test (13). These hubs accept program exit impulses to cause the accumulator to read out without resetting. At the same time, a zero test is made of the accumulator. The results of this test are then available at the zero or non-zero hub on the control panel. Normally the zero test is made of the whole accumulator. If a shift is programmed on the same step, the test will be made beginning at the position called for by the shift and continuing through the high order position.

Accumulator Reset (14). These hubs accept program exit impulses to cause the accumulator to reset to zero at the beginning of the next program step. When impulsed on the same program step as divide, the remainder will be reset at the beginning of the next program step. Impulsing accumulator reset does not affect the normal operation of the next program step.

½ Adjust (15). These hubs will accept program exit impulses to cause a 5 to be added or subtracted in the units position of the accumulator, depending on whether the accumulator is plus or minus. By wiring the shift unit on the same program step, the 5 can be entered in any of nine positions.

Storage Reset (16). These hubs accept program exit impulses on the same step as a storage read-out is impulsed to cause the particular word being read out to also be reset to zero.

Program End (17). These hubs accept program exit impulses, test impulses, or the output of a coincidence switch to signal the calculator that the calculation is complete and the card is ready to be punched.

Program Stop (18). These hubs accept program exit impulses, test impulses, or the output of a coincidence switch to stop the program sequence. These hubs are active only when the machine is under control of the program select stop key.

Read Units Into, Out of (19). There are ten rows of eight common hubs each in this shift control unit. Each row has two labels, READ UNITS INTO and READ UNITS OUT OF. The hubs labeled READ UNITS INTO 1 are common with the hubs labeled READ UNITS OUT OF 10. The hubs labeled READ UNITS INTO 2 are

common with the hubs labeled READ UNITS OUT OF 9, and so on.

The READ UNITS INTO hubs can be used on any operation when the accumulator is being read into. These operations include add, subtract, reset add, reset subtract and ½ adjust. They can also be used when using the electronic digit emitter to read into a storage word. They cannot be used when transferring information from one storage word to another.

The READ UNITS OUT OF hubs can be used only on an accumulator read-out operation.

These hubs should not be impulsed on the same program step as multiply or divide.

Digit Emitter—Units (20). These hubs accept impulses from the program exit hubs to place the wired value on the low-order channel. Any storage word or the accumulator wired to read in on the same program step will accept the digit placed on the channel by the emitter. The digit normally goes to the units position but may be shifted up to nine positions to the left.

Emitter—Tens (Optional) (20). The operation of this emitter is similar to the units emitter except that the digit normally goes to the tens position. It also may be shifted up to nine positions to the left.

Emitter—Hundreds (Optional) (20). The operation of this emitter is similar to the units emitter except that the digit normally goes to the hundreds position. It also may be shifted up to nine positions to the left.

Emitter—Thousands (Optional) (20). The operation of this emitter is similar to the units emitter except that the digit normally goes to the thousands position. It also may be shifted up to nine positions to the left.

Program Expanders (21). Each expander has one IN hub and two double-position OUT hubs. When a program exit is wired to the IN hub, the OUT hubs can be used to provide program impulses to two separate functions. Two or more expander IN hubs may not be split-wired from the same program exit. The OUT hub of one program expander may be wired to the IN hub of another. Ten program expanders are standard.

Coincidence Switches (29). There are two separate IN hubs and two common OUT hubs for each switch. Both IN hubs must receive an impulse at the same time for the OUT hubs to emit. One IN hub may be wired from a test pulse and the other wired from a program exit. The OUT hub can then be wired to pick up an electronic selector. Ten coincidence switches are standard.

Electronic Selectors (30). Each selector has a pickup and drop-out hub which may be impulsed from a program exit or coincidence switch. When the pickup hub is impulsed, the selector transfers immediately. It will remain transferred until the drop-out hub is impulsed or until the end of the card feed cycle. It may be used to control the next program step. Ten single-position electronic selectors are standard.

Output Selectors (28). Both pickup hubs must be impulsed at the same time during calculate time to transfer the selector, located on the punch control panel, for the next card feed cycle.

Calculator Selectors (5). The pickup hubs for these selectors are located on the punch control panel. When impulsed, a calculator selector holds through calculate time and is normally used to control program steps. Eight 5-position calculator selectors are standard.

Accumulator Balance + (22). These hubs emit an impulse at the end of every program step on which the accumulator is positive.

Accumulator Balance — (25). These hubs emit an impulse at the end of every program step on which the accumulator is negative.

Zero (23). These hubs emit an impulse at the end of the program step on which the accumulator read-out and zero test hub is impulsed, if the accumulator contains a plus or minus zero balance.

Non-Zero (26). These hubs emit an impulse at the end of the program step on which the accumulator read-out and zero test hub is impulsed, if the accumulator is not zero.

Divide Overflow (27). These hubs emit an impulse when the quotient exceeds nine digits.

Accumulator Overflow (24). These hubs emit an impulse on any addition or multiplication operation during which the capacity of the accumulator is exceeded.

Bus. Several groups of bus hubs are provided.

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First Reading (2). These hubs are the exits from the 80 columns of the card at the first reading station.

Storage Entry (5). These hubs are entries to the storage words. They may be wired from first or second reading and the digit selectors. Two sign entry hubs are provided for use when the sign indication punch is in a column other than the units or seventh position. The sign hub next to the units position controls the sign of the 9-digit word or the 6-digit word. The sign hub next to the high-order position controls the sign of the 3-digit word only. These sign hubs will accept any digit impulse to indicate a negative sign.

When the negative sign indication for the 9-digit word or the 6-digit word is an X over the units position, no wiring to the right-hand sign hub is necessary. When the negative sign indication for the 3-digit word is an X over the seventh position, no wiring to the left-hand sign hub is necessary.

When a storage word is read into from the 535, all nine positions of the word will be reset.

Storage Read-In (6). These hubs accept card cycles impulses to cause the storage word wired to be reset and read into from the 535.

Storage Exit (7). These hubs are the output from the ten storage words that are used for punching. The output pulses may be selected. The storage words do not reset when reading out to punch.

Storage Read-Out (10). These hubs accept card cycles impulses to cause the wired word to read out to punch.

Punching (11). These hubs are the entries for punching. They may be wired from storage exits, first or second reading, and the digit selectors to cause punching.

When the negative sign for the 9-digit word or the 6-digit word is to be an X punched over the units position, no wiring to the right-hand sign hub is necessary. When the negative sign for the 3-digit word is to be an X punched over the seventh position, no wiring to the left-hand sign hub is necessary. When the sign indicating X punch is to be in other than the two above positions, either the right-hand (6 and 9-digit words) or the left-hand (3-digit word) sign hub may be used.

Punch Selectors PU (8). These are the pickup hubs for the punch selectors. When impulsed, the selector transfers immediately and remains transferred until the end of the card feed cycle. Pickups are normally impulsed from the first or second reading, or from the coupling exit of a pilot selector.

Punch Selectors (3). Eight 5-position punch selectors are standard. They are picked up as described above. To select the information being read at first reading, the pickup hubs should be impulsed from first reading. To select the information being punched, the pickup hub may be impulsed from the coupling exit of a pilot selector which had previously been impulsed from an X or D at first reading. Punch selectors may also be used for interspersed or offset gang punching. When so used, they may be impulsed from second reading.

Second Reading (12). These hubs are the exits from the 80 columns of the card at the second reading station. They may be used for gang punching, checking and DPBC detection.

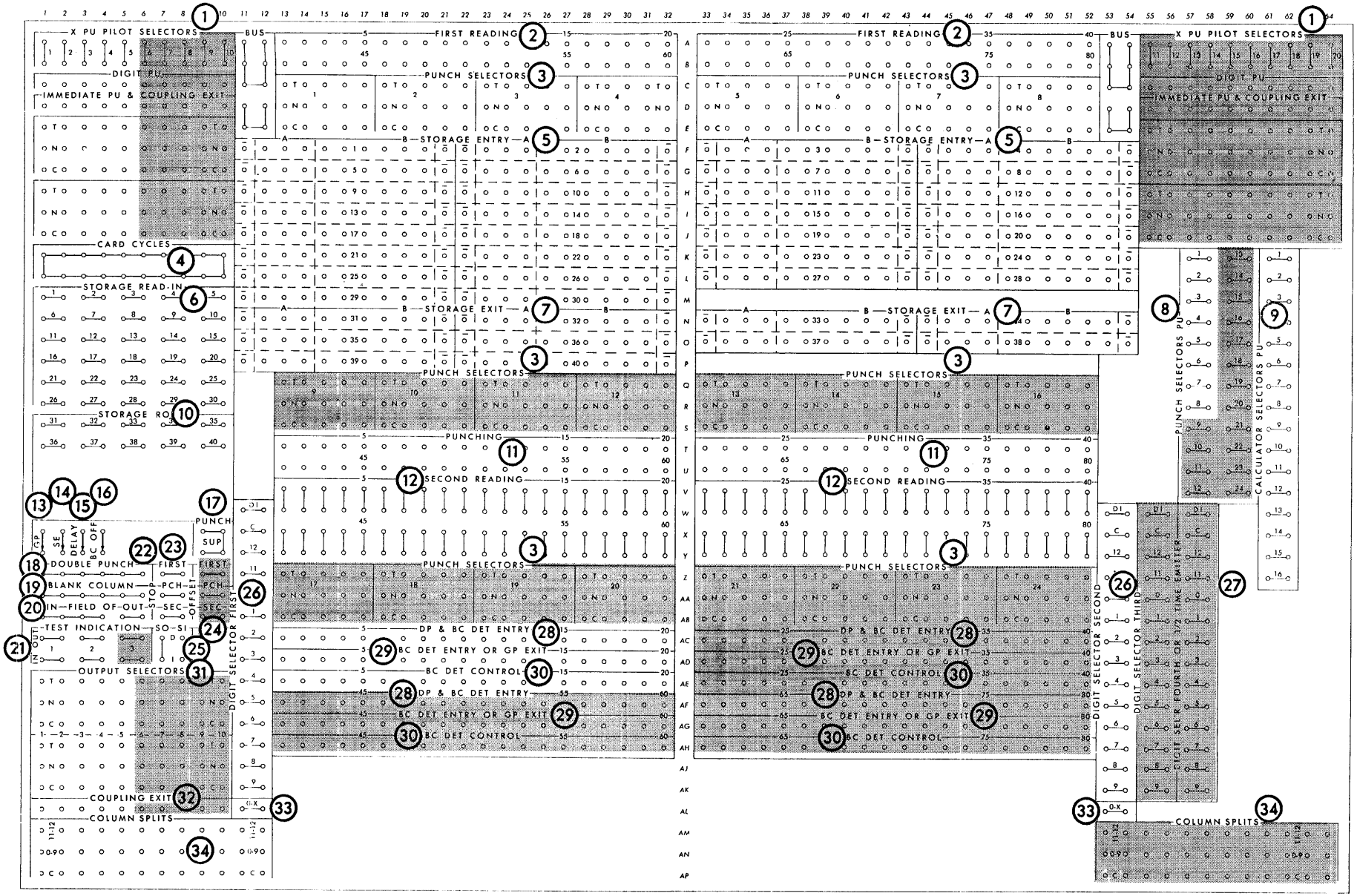
Double Punch and Blank Column Detection Entry (28). These hubs are the entries for checking the presence of double punching or blank columns. They may be wired from first or second reading. Twenty DPBC positions are standard.

Blank Column Detection Entry or Gang Punch Exit (29). These hubs, when wired to either first or second reading, will check the field for blank columns only. They are also exits from the DPBC detection entry hubs. If a column being checked should have a double punch, only the lowest digit punched will be available at these hubs.

Blank Column Detection Control (30). These hubs are used with the DPBC entry and the BC detection entry hubs to define field length when checking for blank columns. By means of control panel wiring it is possible to check a field for double punches only, blank columns only, or both double punches and blank columns.

BC (Blank Column) Off (16). This switch is wired at all times when blank column checking is not done. BC is an exit hub and OFF is an entry hub. Wiring from BC to OFF can be selected with a pilot selector.

DI (Digit Impulse) (26). These hubs emit timed digit impulses 12 through 9 on every cycle. When a digit selector C hub is wired from a DI hub, the digit selector becomes a digit emitter.



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Digit Selector (26). When the C hub is wired from first or second reading, impulses from the digit hubs will be available as the corresponding digits are read from the card. Two digit selectors are standard. Two more digit selectors are available on an optional basis or one of the optional digit selectors may be had as a half-time emitter.

Half-Time Emitter (27). This is an optional feature. It will emit impulses from 12½ to 9½ during card feed time. When the half-time emitter is installed it takes the place of the fourth digit selector.

0-X (33). These hubs emit both a 0 and an X impulse on every card feed cycle.

Column Splits (34). Twelve column splits are standard. They are used to separate 0-9 punches from 11-12 punches.

Calculator Selectors PU (9). These are the pickup hubs for the calculator selectors located on the calculator control panel. They may be wired from first reading or the coupling exit of a pilot selector.

Punch Sup (17). These hubs will accept any digit impulse to cause punching to be suppressed on the following card feed cycle.

Pilot Selectors (1). Five 2-position pilot selectors are standard. Each selector has three pickup hubs, X, D and Immediate. When either the X or D hubs are impulsed, the selector transfers on the following card feed cycle and returns to normal at the end of that cycle. When the immediate pickup hubs are impulsed, the selector transfers immediately and returns to normal at the end of the same cycle. When either the X or D hubs are impulsed, the immediate pickup and coupling exit hub will emit a short impulse at the beginning of the next cycle which can be used to pick up a punch or calculator selector.

GP (Gang Punch) (13). This switch must be wired when the 535 is to be used for independent operation. When using the 535 with the calculator unit, this switch must not be wired.

Delay (15). When these hubs are wired together, they will delay the movement and punching of the card until calculation is completed.

SE (Sign Eliminated) (14). When this switch is wired, calculate time is extended through X reading or punching time. It should be wired only when no negative factors, indicated by X punching, are read into storage from the card or out to punch from storage.

First Stop-Offset (22). These hubs are entries that accept X impulses. Impulsing the stop hub will cause the machine to stop three cycles later. Impulsing the offset hub (optional) will cause a card to be offset in the stacker three cycles later. These hubs are used to indicate an error condition that is recognized at the first reading station.

Punch Stop-Offset (23). These hubs are entries that accept X impulses. Impulsing the stop hub will cause the machine to stop two cycles later. Impulsing the offset hub (optional) will cause a card to be offset in the stacker two cycles later. These hubs are used to indicate an error condition that is recognized at the punch station, such as field overflow.

Second Stop-Offset (24). These hubs are entries that accept X impulses. Impulsing the stop hub will cause the machine to stop one cycle later. Impulsing the offset hub (optional) will cause a card to be offset in the stacker one cycle later. These hubs are used to indicate an error condition that is recognized at the second reading station, such as double punching and blank columns.

Field Overflow-In, Out (20). The IN hubs are wired from one or more storage exit hubs that are in excess of the number of hubs wired to punch the result. If any digit other than a zero is sensed, the field overflow light will come on and the OUT hub will emit an X impulse on the following cycle. The OUT hub may be wired to stop the machine, with the error card in the stacker, by wiring it to the punch stop hub.

SO (Selected Output)—SI (Selected Input) (25). The SI D hub will accept any digit impulse and the I hub will accept a 12 impulse or the impulse from the coupling exit of an output selector. When either of these hubs is impulsed, the selected stop light comes on. The SO hub will emit an X impulse on the same cycle as the I hub is impulsed or one cycle later if the D hub is impulsed. This SO impulse may be wired to stop the machine.

Double Punch (18). These hubs emit an X impulse when the DPBC unit senses a double-punch condition. They may be wired to second stop to stop the machine with the error card in the stacker.

Blank Column (19). These hubs emit an X impulse when the DPBC unit senses a blank column con-

dition. They may be wired to second stop to stop the machine with the error card in the stacker.

Card Cycles (4). These hubs emit an impulse on each card feed cycle. This impulse may be used to control functions at all three stations simultaneously. It begins just before X time and lasts through 9 time. Therefore, this impulse cannot be selected through the normal side of a selector picked up immediately by an X impulse.

Test Indication In-Out (21). Either IN hub will accept any digit pulse. When the IN hub is impulsed, its corresponding test indication light is turned on and the associated OUT hub will emit a 0-X impulse on the following cycle. This impulse may be wired to stop the machine. Two test indication units are standard.

Output Selectors (31). The pickup hubs for these selectors are located on the calculator control panel. When the pickup hubs are impulsed, the selectors transfer for the following card feed cycle. The pickup hubs may be impulsed by any of the test impulses such as zero, non-zero, and so on.

Coupling Exit (Output Selectors) (32). These hubs emit an impulse for the complete cycle on which the selector is transferred. This impulse may be wired to stop the machine or to pick up a punch selector.

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