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Systems

IBM 3250 Graphics Display System Continuous Refresh (RPQs 7J0024 and 7J0025) Custom Feature User's Guide

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This major revision obsoletes GA33-3085-0. The revision incorporates changes brought about by the introduction of the IBM 3255 Display Control Unit Model 2. Changes or additions are indicated by a vertical line to the left of the change.

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Preface

This publication describes the functional enhancements provided on an IBM 3250 Graphics Display System by the Continuous Refresh custom feature. Continuous refreshing allows communication between the IBM 3255 Display Control Unit and the application program in the host system without interrupting the regeneration of the displayed image. A 3250 Graphics Display System with Request for Price Quotation (RPQ) 7J0025 installed at the 3255 is able to use continuous-refresh mode and the accompanying enhancements.

With the exception of CANCEL key operations and buffer programs containing certain undefined orders, the continuous-refresh enhancements have no impact upon 3250 applications that do not use the enhancements. For details, see Chapter 3 of this publication.

The information in this publication is arranged as follows:

- **Chapter 1. Introduction**: Provides an overview of the Continuous Refresh RPQs and the functional enhancements that support the use of continuous-refresh operations.
- **Chapter 2. Continuous-Refresh Mode**: Provides reference information for the application programmer.
- **Chapter 3. Compatibility Considerations**: Provides assistance in migrating an application program to a 3250 system that can operate in continuous-refresh mode.
- **Appendix A. Channel Commands**: Lists the channel commands used with a 3250 system and notes the effect-continuous refresh mode has on the execution of those commands.
- **Appendix B. Assembler Language Macros**: Contains sample macros for the GSRTE and GTCT buffer orders.
- **Bibliography and Index**.

Note: References in this publication to the IBM 3255 Display Control Unit apply both to the 3255 Model 1 and to the 3255 Model 2. Both models of 3255 can function in the same way in the same environment. However, the 3255 model 2 operates slightly faster than the 3255 Model 1.

Contents

Chapter 1. Introduction

The IBM 3250 Graphics Display System provides interactive graphics capabilities for its host system. Graphic and alphanumeric information is displayed on a cathode-ray tube. Two types of keyboard and a light pen may be installed to allow the operator to interact with the displayed image and the host system, and to update stored data.

Image Regeneration

A buffer program contains the orders and data that control the generation of an image at the IBM 3251 Display Station. The buffer program is stored and executed in the display buffer of the IBM 3255 Display Control Unit to which the 3251 Display Station is attached. By repeated execution of this buffer program, the image is regenerated on the screen. The application program in the host system updates the buffer program to change the displayed image.

The user of a 3251 interacts with the application program by making a light-pen selection, pressing a program function key, or pressing the END or CANCEL keys on the alphanumeric keyboard. These actions cause an input/output (I/O) interruption to be raised at the host system to indicate that a 3255 requires service for an attached 3251. When interrupting on behalf of a light-pen selection, the 3255 terminates the buffer program. If, in response to an interruption, the application program has to write data to or read data from the display buffer, the application program must first terminate execution of the buffer program. Terminating the buffer program stops regeneration of the displayed image; the application program must restart the buffer program after completing the data transfer.

Thus, communication with the host system can interrupt the display. The main factor affecting the time for which the display remains blank is the response time from the host system. In certain applications, the 3251 user may find that the periods without a displayed image are detrimental to efficient operation.

If the image is continuously refreshed (regenerated), however, the displayed image is not lost during an interruption to the host program.

Continuous Refreshing

A 3251 Display Station attached to a 3255 Display Control Unit Model 1 modified with the Continuous Refresh custom feature, is able to work in continuous-refresh mode. This mode of operation permits channel operations to write data into a program-defined batched write record receiver in the display buffer and to read data from the display buffer without first terminating execution of the buffer program.

In addition to continuous-refresh mode, the Continuous Refresh custom feature includes enhancements to the 3255 that allow the application programmer to take full advantage of operating in continuous-refresh mode. The functional enhancements provided are:

- **Mode Switching**: Continuous-refresh mode may be switched on and off dynamically for each 3251 attached to a modified 3255. Using the Set Buffer

Address Register and Start channel commands, the application program can set the appropriate mode whilst the 3251 is being used without affecting other 3251s attached to the same 3255. A sense bit is defined which indicates whether or not the 3251 is operating in continuous refresh mode.

- **Buffer-Running Sense Bit**: Channel commands that write or read the display buffer are not accepted by the 3255 when the buffer-running bit is on for the addressed 3251. When a 3251 is operating in continuous refresh mode, a Set Buffer Address Register and Stop command will reset the buffer-running sense bit without terminating the buffer program.

- **Batched Write Command**: Write Buffer commands issued to a 3251 operating in continuous refresh mode are interpreted as Batched Write commands. The application program can "batch" small changes to the buffer program and issue a Write Buffer command to transfer the changes to a batched-record receiver in the display buffer.

- **Read Commands**: Channel commands that read data from the display buffer or that insert or remove the cursor may be issued to a 3251 operating in continuous refresh mode provided that the buffer-running bit is off when the command is received. The channel command and the buffer program contend for access to the display buffer.

- **Extended Start Regeneration Timer (GSRTE) Order:** The Start Regeneration Timer (GSRT) order is extended to contain additional controls and an optional address field. GSRTE supports all GSRT functions and, in addition, is able to:

  - Enable or disable input via the alphanumeric and program function keyboards

  - Test the status of the manual input register and cause a branch if the register is busy

  - Simulate manual input by setting an END, CANCEL, or PF (program function) key code into byte 0 of the manual input register for transmission to the application program.

  These extensions provide a means of transferring deferred light-pen detections to the application program as simulated manual input. This avoids having to terminate regeneration of the image when transferring information relevant to a light-pen operation.

- **Transfer on Count (GTCT) Order**: A Transfer on Count buffer order is added to the set of buffer orders. This order allows the application programmer to include simple loops in the buffer order program.

- **CANCEL Key Usage**: The usage of the alphanumeric CANCEL key is changed on all 3251s attached to a 3255 that has been modified for continuous refresh. Regardless of the mode of operation, CANCEL is not accepted unless the CONTINUOUS key is held down when the CANCEL key is pressed. This change in usage decreases the possibility of I/O interrupts being raised by accidental operation of the CANCEL key.

Application Program Considerations

To take full advantage of continuous refresh mode, the application program should:

- Issue the mode-setting Set Buffer Address Register commands.
- Format updates to the buffer program as batched write records.

  Note: These records are only valid when the addressed 3251 is in continuous refresh mode.

- Allocate up to 512 bytes in the display buffer as a receiver area for batched write records.
- Contain a routine that will identify whether the data returned in response to a Read Manual Input command is simulated manual input set by GSRTE or manual input set by one of the interrupt-generating keys.

  Note: If the buffer program accepts the selection of an option on the screen and returns the same code as returned for the same option on the program function keyboard, changes to the application program may be avoided.

- Restructure the buffer program to:
  - Use the Extended Start Regeneration Timer (GSRTE) order rather than the GSRT order.
  - Avoid using the light-pen mode of detects-enabled with immediate response. (This mode is set by default when a GSRT or GSRTE buffer order is being executed.)
  - Avoid those orders that terminate the buffer program and raise an immediate I/O interruption to the host system:

    Permit Detect Interrupt (GPDI) order

    End Order Sequence (GEOS) order

  - Include simple routines that accept deferred light-pen detections and, using the functions provided by GSRTE, set a code into the manual input register. (Deferred light-pen detections can be queued in a program-defined area and the simulated manual input can request the application program to access the queue.)

Note: Most application programs that do not use continuous refresh should be able to migrate to a system capable of operating in continuous refresh mode without any changes. The incompatibilities are described in Chapter 3.

Chapter 2. Continuous-Refresh Mode

Continuous-refresh mode is available at all 3251s attached to a 3255 modified by a Continuous Refresh request for price quotation (RPQ). When a 3251 is set to continuous-refresh mode, communication between the buffer program and application program need not terminate regeneration of the displayed image.

Mode Switching

The application program uses particular forms of the Set Buffer Address Register channel commands to set continuous refresh mode on and off.

Entering Continuous Refresh Mode

To set continuous-refresh mode on at a 3251, the application program must address the 3251 and issue a Set Buffer Address Register and Start command with X'FFFF' as the address operand. SBA and Start with X'FFFF' does not change the status of the buffer program; this version of SBA and Start sets the buffer-running and continuous-refresh sense bits (bit 6 of sense byte 0 and bit 3 of sense byte 1 respectively) but does not initiate execution of the buffer program or change the content of the buffer address register.

Having established continuous refresh mode, the application program should start the buffer program and reset the buffer-running sense bit. The following sequence of commands may be used to set continuous refresh on, start the buffer program, and reset the buffer-running sense bit without terminating the buffer program:

SBA and Start with X'FFFF' to set continuous-refresh mode

SBA and Start with a "real" address to start the buffer program

SBA and Stop with a "real" address to reset the buffer-running sense bit.

Leaving Continuous-Refresh Mode

When a 3251 is operating in continuous refresh mode, continuous refresh is ended and the buffer program is terminated by:

1. Receipt of a Set Buffer Address Register and Stop command specifying a buffer address of X'FFFF'

2. A Batched Write command attempting to write data into a receiver that starts on an odd-byte boundary

3. Receipt of a Batched Write record that has an invalid record header

4. The buffer program raising an I/O interruption to the application program (see Note) as a result of:

   - Executing a Permit Detect Interrupt (GPDI) order with an outstanding deferred light-pen detection.

- A light-pen detection when the current light-pen-response mode is immediate. (This response mode is the default set by execution of the GSRT and GSRTE orders or is specifically set by the GPDI order.)

- Executing an End Order Sequence (GEOS) order.

Note: Without the continuous refresh modification, or with continuous refresh switched off, these events raise an Attention/Unit-Check interrupt. Buffer programs running in continuous refresh mode are terminated by these events but no I/O interruption is raised to the application program if the buffer-running sense bit (bit 6 of sense byte 0) is off when the event occurs. Terminating the buffer program always sets the appropriate sense information regardless of whether or not an I/O interruption is raised.

Set Buffer Address Register Commands

The Set Buffer Address Register channel commands, SBA and Start and SBA and Stop, are used as the primary controls for switching continuous refresh on and off from the application program.

These two commands, with a "real" buffer address in the address operand, transfer two bytes of data to the buffer address register for the selected 3251. SBA and Start transfers the two bytes and execution of the buffer program starts at the addressed location. SBA and Stop sets the buffer-running sense bit off and transfers the two bytes to the buffer address register; if the 3251 is not operating in continuous refresh mode, then SBA and Stop terminates the buffer program.

If the address operand of these commands contains X'FFFF', the 3251 interprets the commands as controls for continuous refresh.

The following table shows the effect of issuing one of the Set Buffer Address Register commands to a 3251 and, where applicable, the differences that occur depending upon whether continuous refresh is on or off when the command is issued:

Channel Command and Address Operand	Continuous Refresh Mode	Buffer Program Status	Buffer Address Register	Buffer-Running Sense Bit
SBA-Start, Real	Unchanged	Running	Real	On
SBA-Start, X'FFFF'	On	Unchanged	Unchanged	On
SBA-Stop, Real:				
Cont. Refresh On	Unchanged	Unchanged	Real	Off
Cont. Refresh Off	Unchanged	Terminated	Real	Off
SBA-Stop, X'FFFF'	Off	Terminated	X'7FFF'	Off

Note: The Graphics Access Method (GAM) does not support X'FFFF' as a valid buffer address for the SBA commands. The EXCP interface should be used to issue this version of the SBA commands to a 3251 (see "Mode-Switching from Programs using GAM" in Chapter 3).

Batched Write Command

A Write Buffer channel command issued to a 3251 that is capable of running in continuous refresh mode is processed as a Write Buffer command when continuous refresh is off and as a Batched Write command when continuous refresh is on. Regardless of the status of continuous refresh, a Write Buffer command will be rejected if the buffer-running sense bit (bit 6 of sense byte 0) is on when the command is received.

Batched Write transfers a formatted record to a program-defined 'batched write record' receiver area in the display buffer. The batched write record consists of a header with one or more variable-length fields, each field containing a separate update to the buffer program. A Set Buffer Address Register and Stop command issued prior to the Write Buffer command sets the address of the start of the receiving area into the buffer address register. Upon completion of the data transfer to the receiver, the fields are unpacked into the display buffer locations identified at the start of each field.

The "ending" status for this command is presented to the channel before the data is unpacked. The selected 3251 can immediately accept any channel command except Batched Write, but execution of the command will be delayed until the batched write record has been unpacked. Consecutive Batched Write commands should not be used, and the result is unpredictable.

Notes:

1. The address of the receiving area must be even; the batched write record is invalid if the address is odd.

2. If the cursor is located in the receiving area, the cursor is removed when the batched write record overwrites data at the cursor location. Unpacking data from the receiving area into the cursor location does not remove the cursor.

Batched Write Records

Formatted batched write records contain a header followed by one or more data fields of variable length. Each data field starts with a destination address and a byte count of the data in the field. The maximum length of a batched write record is 512 bytes (including the 6-byte record header).

The header field and data fields of a batched write record must start on even-byte boundaries in the receiver area. To successfully unpack an odd number of bytes, the length for that data field should show the actual number of data bytes to be unpacked and a pad byte should be added to the end of the data.

Note. It is the programmer's responsibility to:

1. Correctly format a batched write record.

2. Assign an adequate receiving area that does not require the buffer address to wrap from 32767 to 0 while writing the record.

3. Ensure that each data field in the record can be unpacked without the buffer address wrapping from 32767 to 0.

4. Ensure that unpacking the record will not corrupt the buffer program of the selected 3251 or of other 3251s attached to the same 3255.

A batched write record with an invalid record header sets continuous refresh off and terminates the buffer program. No attempt is made to unpack the data fields if the header is invalid.

When the record is unpacked, unpacking is terminated if:

- The address and length subfields of a data field indicate that the unpacked data would wrap from buffer address 32767 to address 0, or
- The length subfield of a data field indicates that the data extends beyond the record length defined in the header.

The batched write record has the following format:

Header

TYPE	16-bit code, either X'0001' or X'0003'
RESTART ADDRESS	16-bit restart address (or X'FFFF' to indicate no restart address)
DATA LENGTH	16-bit unsigned integer, being the length of the remainder of the Batched Write record (maximum value, 506 bytes)

Data Field 1 (Optional)

ADDRESS	16-bit Display Buffer address of the first byte to be overwritten by this change. (Values outside the range 0 through 32767 cause termination of unpacking.)
LENGTH	16-bit unsigned integer, being the length of the DATA subfield in bytes
DATA	n bytes of data, n being the value in the immediately preceding LENGTH subfield

Data Field 2 (Optional)

.
.
.

Record Header

Type: A 2-byte field defining the type of record. The valid type codes and their functions are:

X'0001': The buffer program for the addressed 3251 is terminated, the data fields contained in the record are unpacked, and buffer program execution restarts at the address, if any, specified in this record header.

X'0003': The data fields contained in the record are unpacked without terminating the buffer program. If the buffer program was not running when this record was transferred, execution starts at the address, if any, specified in this record header.

Note: Because the buffer program is not terminated when a type X'0003' record is unbatched, a valid buffer program must exist after the transfer of each even-odd pair of bytes from the data field(s) to the display buffer.

X'0007': Type X'0007' must not be used by application programs. This type is reserved for diagnostic and model-dependent functions.

Restart Address: A 2-byte field defining the start address for the buffer program. If the restart address is X'FFFF', the buffer program is not restarted after unpacking a type X'0001' record. Nor is the buffer program restarted after unpacking a type X'0003' record, if the buffer program was not running when the record was transferred.

Data Length: A 2-byte field defining the total length of the data fields following this header. Valid lengths are zero through 506 (X'01FA') providing that writing the record into the receiving area would not require the buffer address to wrap from 32767 to 0. The data length field should reflect the total length including any pad bytes appended to data fields containing an odd number of data bytes.

Note: The data length field is used to count the data during the unpacking process, not as a count during the transfer of batched write data from the I/O channel. If the length specified by the data length field is less than the record transferred, unpacking will stop before the end of the record. If it is more, unpacking will continue beyond the record.

Data Field

Address: A 2-byte subfield defining the destination address for unpacking the data contained in this data field. The address may be odd or even.

Notes:

1. Unpacking is terminated if the address subfield and length subfield together indicate that unpacking the data field would require the buffer address to wrap from 32767 to 0.

2. Data should not be unpacked into the batched write record receiver area; the result of this is unpredictable.

Length: A 2-byte subfield defining the length of the data contained in this data field that is to be unpacked. The length may be odd or even.

Note: If the length subfield indicates that the data field extends beyond the record length defined in the header, unpacking is terminated.

Data: A variable length subfield containing data that is to be unpacked to the display bufffer. The data subfield must start on an even-byte boundary. If the data contains an odd number of bytes and another data field follows in the batched write record, a pad byte must be added to this data subfield to ensure that the next field starts on an even byte boundary. (A pad byte is not unpacked if the length subfield is exhausted at the last data byte.)

Example of a Batched Write Operation

This example illustrates the transfer of a batched write record to the receiving area and the unpacking of that record into the buffer program.

Channel Program

The following channel commands are issued by the application program:

1. Set Buffer Address Register and Start, address = X'FFFF'
2. Set Buffer Address Register and Stop, address = X'2000'
3. Write Buffer (Batched Write), byte-count = X'0020', host-address = LOC A
4. Set Buffer Address Register and Stop, address = X'2000'
5. Write (another Batched Write), byte-count = ...

Batched Write Record

The hexadecimal value of the data starting at LOC A in the host system is:

Record Header	0001	Type 1
	2200	Restart address
	001A	Total length of data fields
Data Field 1	2300	Destination address
	0008	Length of data subfield
	2A40	Enter character mode order
	C1C2	Characters 'AB'
	2AFF}	GTRU order and Transfer address
	2310}	
Data Field 2	2400	Destination address
	000A	Length of data subfield
	....	followed by 10 bytes of data

Program Execution

When the channel program is executed:

- Command (1) sets continuous refresh mode on at the addressed 3251.
- Command (2) sets the buffer address register to X'2000' to identify the start of the receiver area.
- Command (3) transfers 32 (X'0020') bytes of data from the host system to the display buffer, transfer starts at LOC A in the host system and address

X'2000' in the display buffer. 'Ending' status is returned upon the completion of data transfer to the batched-record receiver in the display buffer.

- Command (4) is issued to, and accepted by, the 3251 but is not executed immediately.
- After unpacking the batched write record, command (4) is executed to reset the buffer address register to X'2000'.
- Command (5) initiates the transfer of another batched write record into the receiver.

Unpacking the Batched Write Record

The record is unpacked as follows:

- Because this is a type X'0001' record, execution of the buffer program is terminated before the data is unpacked.
- The 8 bytes of data contained in the first data field are unpacked into the display buffer starting at location X'2300' and ending at location X'2307'.
- The 10 bytes of data contained in the second data field are unpacked into the display buffer starting at location X'2400' and ending at location X'2409'; unpacking the tenth byte into location X'2409' exhausts the data length defined in the record header.
- The buffer address register is set to the restart address (X'2200') and execution of the buffer program starts.

Extended Start Regeneration Timer (GSRTE) Order

The Start Regeneration Timer (GSRT) order synchronizes regeneration of the displayed image. GSRT also synchronizes input to the host system from the interrupt-generating keys (the END, CANCEL, and program function keys).

Pressing an interrupt-generating key raises a request to the buffer program. At the next execution of a GSRT order, a key-code is set into the 3-byte manual input register and an I/O interruption is raised to the host system. Setting a code into the register causes the register to become busy; this status remains active until a Read Manual Input channel command transfers the code from the register to the host system. Execution of the buffer program is not terminated for an I/O interruption raised on behalf of manual input.

A 3255 that has been modified for continuous refresh supports an Extended Start Regeneration Timer (GSRTE) order that provides all GSRT functions and, in addition, may be used to:

- Disable or enable input from the alphanumeric and program function keyboards
- Test whether or not the manual input register is busy waiting for input to be transferred to the host system

- Set a valid code into the manual input register in order that an I/O interruption may be raised to the host system without terminating regeneration of the displayed image.

These additional controls enable the manual input register to be used to pass information to the application program without raising an I/O interruption that requires termination of the buffer program. The information passed may refer to deferred light-pen detections. Using the Transfer on No Detect (GTND) and Transfer on Deferred Detect (GTDD) buffer orders, the buffer program can accept deferred light-pen detections and either:

- Modify the GSRTE controls in order to transmit each detection to the host system as manual input, or

- Queue information pertaining to the detections and, at a suitable time, modify the GSRTE to transfer manual input to the host system in place of the light-pen detections. (Upon receipt of the simulated manual input, the application program should read the queued information and reset the queue.)

Notes:

1. A buffer program that transfers light-pen detections as simulated manual input should (1) upon receiving the detection, modify the GSRTE order so that at the next execution it disables the interrupt-generating keys and tests for a busy condition, and (2) if the manual input register is free, use the routine following the GSRTE order to set the controls needed to make the next execution of GSRTE simulate the required manual input.

2. The GSRTE order is not supported by the IBM Graphic Programming Services (GPS). A sample macro, in assembler language, is given in Appendix B.

Order Format

The GSRTE order is a control-mode order of 4 or 6 bytes, depending upon the flags set in the fourth byte. Bytes 0 and 1 contain the code of a GSRT order (X'2A82') and the first 12 bits of bytes 2 and 3 are zero. The code in the first two bytes initiates a GSRT sequence; a zero in the third bit of the next byte requests a modified 3255 to perform one of the extended functions.

	Byte 0	Byte 1	
First Word	0010 1010	1000 0010	Hex 2A82
Second Word	0000 0000	0000 kmtt	Flags
Third Word	aaaa aaaa	aaaa aaaa	Storage address (optional)

Legend:

k Keyboard Enable/Disable:
k = 0 enables the keyboards.
k = 1 disables the keyboards.

m Manual Input Register:
m = 0 specifies that the manual input register functions are not required.
m = 1 specifies that the manual input register functions are required and signifies that this order is six bytes long.

t These two bits define the type of operation to be performed on the manual input register:
tt = 00 tests to see if the manual input register is busy.
tt = 01 sets a simulated END key operation.
tt = 10 sets a simulated CANCEL key operation.
tt = 11 sets a simulated program function key operation.

a Display Buffer Address:
(1) If mtt = 100 the manual input register is tested for a busy condition:
- If the register is busy, control is transferred to the buffer order at the location addressed by these two bytes.
- If the register is not busy, the next sequential order is accessed.

(2) If mtt = 101, 110, or 111, data from the addressed location is copied into bytes 1 and 2 of the manual input register. (Byte 0 is set according to the type of operation requested by the t bits.)

Note: The low-order and high-order bits of the address are ignored to force addressing on an even-byte boundary at a valid address.

0 These bits must be 0.

Execution Time

If a GSRTE order attempts to set information into the manual input register when the register is busy, execution is not completed until the register becomes free. Providing that execution is not delayed in this way, the execution time of a GSRTE order is nominally 750 microseconds.

Keyboard Enabling/Disabling

Executing a GSRTE order that has the k bit (bit 12 of the second word) set to 1 disables the alphanumeric and program function keyboards. If the keyboards are disabled, they remain disabled until either:

- A Power-On Reset, System Reset, or Selective Reset is performed
- An SBA and Start command with a "real" address operand is received
- A GSRT order is executed, or
- A GSRTE order with k = 0 is executed.

Notes:

1. Receipt of an SBA and Stop command does not alter the enable/disable state of the interrupt-generating keys.
2. The default keyboard mode is enabled. A GSRTE order with the k bit set to 1 is the only way of disabling the keyboards from the buffer program.

The need for keyboard control arises when the user is queueing light-pen selections in the display buffer. To ensure that the sequence of operator actions is preserved, the buffer program should disable the keys after a light-pen selection; this action prevents any keyboard interrupt whilst the queue is being formed. Depending upon the application, the interrupt-generating keys should be re-enabled either:

- After raising an I/O interruption to notify the application program that a queue has been formed, or
- To avoid the addition of light-pen selections to the queue after a keyboard selection, the interrupt-generating keys may remain disabled until the queue has been cleared.

As an aid to the 3251 user, a BUSY message could be displayed at the 3251 when the keyboards are disabled. The routine to generate this message could be entered after a GSRTE that disabled the keys and after a GSRTE that tested the manual input register and found it busy.

Test Manual Input

Executing a GSRTE order that has the mtt bits (bits 13 through 15 of the second word) set to 100 tests the manual input register for a busy condition:

- If the register is busy, control is transferred to the buffer order at the location addressed by the third word of the GSRTE order.
- If the register is able to accept manual input, control passes to the buffer order following the third word of the GSRTE order.

A busy condition in the manual input register signifies that (1) the register contains data pertinent to the operation, real or simulated, of an interrupt-generating key, (2) an I/O interruption has been raised to the host system on behalf of the manual input register, and (3) a Read Manual Input channel command has not yet been received to transfer the data from the register to the application program.

The need for this control arises when the set-manual-input function of GSRTE is used; a GSRTE that attempts to simulate manual input should not be issued when the manual input register is busy.

Set Manual Input

If the manual input register is not busy, executing a GSRTE order that has the mtt bits (bits 13 through 15 of the second word) set to 101, 110, or 111, will initiate the following functions:

- Load an interrupt-generating key code into byte 0 of the manual input register.
- Load bytes 1 and 2 of the manual input register with the data from the display buffer location addressed by the third word of the GSRTE order.
- Set a busy flag to protect the data in the manual input register (the busy flag is removed when a Read Manual Input command transfers the data to the application program.)
- Raise an I/O interruption (an Attention Interrupt) to the host system to signal that the manual input register contains input for the application program.

Note: A GSRTE that attempts to simulate manual input when the register is busy is not completed until the register is free; thus the buffer program halts temporarily and the displayed image is not regenerated until the manual input register becomes free.

The values loaded into the manual input register depend upon the tt bits and the content of the buffer location addressed by the third word of the GSRTE order:

	Byte 0	Byte 1	Byte 2
tt = 01 (END)	1010 0000	dddd dddd	dddd dddd
tt = 10 (CANCEL)	1001 0000	dddd dddd	dddd dddd
tt = 11 (PF key)	0100 0000	dddd dddd	dddd dddd

Legend:

d data transferred from the location addressed by the third word of the GSRTE order.

When simulating an interrupt-generating key, the location addressed by the third byte of the GSRTE order should contain valid data for the key that is being simulated. The three bytes of data returned by the interrupt-generating keys are as follows:

END: X'A00000'.

> **Note:** The Basic Attention Handling feature of the Graphics Access Method (GAM) recognizes the END code (X'A0') and saves the two data bytes. For a simulated END key, these two data bytes may contain any value and they are made available to the application program as the sixth and seventh bytes of the COMAREA control block.

CANCEL: X'900000'.

> **Note:** The Basic Attention Handling feature of the Graphics Access Method (GAM) recognizes the CANCEL code (X'90') and discards the two data bytes. For a simulated CANCEL key, these two bytes may contain any value.

PF keys: The three bytes of input supplied by a Program Function key contain:

Byte 0	Byte 1	Byte 2
0100 0000	000n nnnn	ssss ssss

Legend:

n the number (binary) of the program function key (X'00' through X'1F').

s set to X'FF' by the 3250 system.

Note: The Basic Attention Handling feature of the Graphics Access Method (GAM) recognizes the PF-key code (X'40') and, providing that the value contained in the second byte is not more than X'1F' (decimal 31), presents the interrupt to the application program. The second and third bytes are made available to the application program via the COMAREA control block; the second manual input byte is saved in the third byte of the control block, and the third manual input byte is saved in the second byte of the control block.

Transfer on Count (GTCT) Order

The range of transfer orders valid for the 3250 system is extended by the Continuous Refresh RPQs to include a Transfer on Count (GTCT) order. This order provides a tool for implementing simple loops in the buffer program and may be used to:

- Reduce the amount of buffer storage required by an interrupt-queueing routine
- Reduce the amount of buffer storage required by a routine that floods the screen with characters.

Transfer on Count (GTCT) is a 4-word control-mode order consisting of a 4-byte order code, a 2-byte destination address, and a 2-byte count field. When executing a GTCT order:

1. The count field is decremented by one.
2. The decremented count is compared with zero.
3. If the count is not zero, control is transferred to the buffer order addressed by the third word of the GTCT order.

Notes:

1. If a deferred light-pen detection is outstanding when GTCT is executed, the deferred detection is cancelled.
2. The GTCT order is not supported by the IBM Graphic Programming Services (GPS). A sample macro, in assembler language, is given in Appendix B.

Order Format

The GTCT order has the following format:

	Byte 0	Byte 1	
First Word	0010 1010	1000 0001	Hex 2A81
Second Word	0010 1010	1111 1011	Hex 2AFB
Third Word	aaaa aaaa	aaaa aaaa	Destination Address
Fourth Word	cccc cccc	cccc cccc	16-bit Count

Legend:

a Destination Address: If the decremented count field is non-zero, control is transferred to the order at this address. (The low-order and high-order bits are ignored to force addressing on an even-byte boundary at a valid address.)

c Count Field: An unsigned 16-bit integer.

Note: The GTCT order code occupies 2 words. The first word of this order contains the End Order Sequence (GEOS) order code, but the GTCT order does not implement any of the functions of a GEOS order.

Execution Time

The execution time of a GTCT order can be up to 370 microseconds.

Note: Because GTCT is slower than all other control-mode orders except GSRTE and GSRTE, using GTCT will reduce the amount of data that can be displayed at the optimum regeneration rate of 46 cycles per second.

Example Using GTCT

The following example shows a compact routine to flood the screen with characters, and uses the GTCT macro given in Appendix B.

```
LOC0  GSRT                          start regeneration timer
      GEVM                          absolute mode, so characters wrap
      GMVD  LOC2+6,BDATA=40         initialize count field
LOC1  GECP  BASIC                   basic size characters
      GTXT  'WWWWWWWWWWWWWWWWWWWW' 40Ws
LOC2  GTCT  LOC1,COUNT=40           loop 40 times
      GTRU  LOC0                    back to top
```

Alphanumeric Keyboard Operations

CANCEL Key Usage

In order to protect against accidental operation of the CANCEL key, the usage of this key is changed on all 3251s attached to a 3255 that has been modified for Continuous Refresh. Regardless of the mode of operation, the CONTINUOUS key must be held down when CANCEL is pressed to initiate the manual input sequence resulting from a CANCEL-key operation.

If CONTINUOUS is not held down, pressing CANCEL activates the keyboard clicker but no input is passed to the manual input register. Holding CONTINUOUS down suppresses the keyboard clicker and enables the CANCEL key.

Note: Each operation of the CANCEL key raises one I/O interruption to the host system; the changed usage does not cause multiple interruptions.

Keyboard Clicker

The operation of the keyboard clicker is not changed for continuous refresh. Thus, using the GSRTE order to disable the interrupt-generating keys does not disable the keyboard clicker; if the clicker is switched on by the CLICK key, pressing the END key activates the clicker without generating an I/O interruption to the host system.

Chapter 3. Compatibility Considerations

Application Programs

Application programs designed for use with systems that are not capable of using continuous refresh may be used with modified systems. Some exceptional conditions exist that would prevent an application program from migrating to a modified system. The conditions that would prevent migration are:

- The application program relies upon the 3250 ignoring undefined orders and data outside a defined context (such as X,Y coordinates or character-mode data) and creates either of the following conditions in the buffer program:
  - A GSRT order followed by a byte containing 0 in the third bit position. (If the third bit is set to 0, the GSRT will be interpreted as GSRTE.)
  - A GEOS order followed by X'2AFB'. (GEOS followed by X'2AFB' will be interpreted as a GTCT order.)
- The application program bypasses Graphics Access Method (GAM) to issue a Set Buffer Address Register (SBA) command with X'FFFF' as the address operand.

All channel commands are accepted by GAM except for the SBA commands with X'FFFF' as the address operand. However, if the addressed 3251 is operating in continuous refresh mode, the data transferred by a Write Buffer command must be formatted as a batched write record.

Application programs being converted to take full advantage of continuous refresh should use the Sense command to determine whether or not a 3251 Display Station is operating in continuous refresh mode. Bit 3 of sense byte 1 is set to 1 when the 3251 is in continuous refresh mode.

In a mixed configuration where continuous refresh may be valid on some 3251s and not on others, the application program may interrogate the 3251s by:

1. Bypassing GAM to issue a Set Buffer Address Register and Start command with X'FFFF' as the address operand.
2. Issuing a Sense command and examining bit 3 of sense byte 1: a 1 indicates that the addressed 3251 is operating in continuous refresh mode.

Cursor Location

Unpacking a batched write record into the display buffer does not remove the cursor if it is located at a byte that is overwritten. Because the cursor location is valid for alphanumeric data entered by the 3251 user, it should only be positioned in a data field that is reserved for keyboard data. If the cursor is located at an address that will be accessed during unpacking, the Remove Cursor or Insert Cursor command should be used to remove or relocate the cursor before transferring the batched write record.

Graphics Access Method (GAM)

Buffer Management

Write Buffer commands are examined to ensure that the data is being written into the portion of the display buffer assigned to the addressed 3251. However, unpacking a batched write record will continue as long as the address is within the range of valid buffer addresses (decimal 0 through 32767). The user must ensure that unpacking a record in one buffer program does not corrupt the buffer programs of other 3251s attached to the same 3255.

The ASGNBFR (Display Buffer Space Management) function of GAM under Multiple Virtual Storage (MVS) will reset continuous refresh mode if the 3251 is operating in continuous refresh mode when the function is invoked. The user must ensure that, if continuous refresh mode is used, recovery is possible after invoking ASGNBFR.

CANCEL Key Usage

If the GAM functions are invoked to process CANCEL-key operations when the 3251 is using continuous refresh mode, then continuous refresh is reset. In particular, selecting RESUME after a CANCEL-key operation may not restart the buffer program. The user must ensure that, if continuous refresh mode is used, recovery is possible after processing a CANCEL-key operation.

Mode-Switching from Programs using GAM

The user interface to a 3251 via GAM does not accept buffer addresses that are not in the range of addresses assigned to the 3251. Thus the mode-setting Set Buffer Address Register commands, with X'FFFF' as the address operand, are rejected by GAM.

The following sequence shows how to use the EXCP interface to forward the mode-setting commands to a 3251 from an assembler language program:

1. **Locate a free input/output block**:

   a. The 4-byte field at offset X'1C' in an Open GAM data control block (DCB) contains the address of the first input/output block (IOB) associated with the device.

   b. The byte at offset X'24' in the IOB is a flag which shows whether the IOB is currently in use. The user should attempt to seize the IOB using a Test and Set instruction on this location. If the attempt fails, the user should try the next IOB - the three bytes from offset X'25' address the next IOB for the device. (The last IOB has X'000000' at offset X'25').

2. **Load the channel command**: The 8-byte mode-setting channel command must be loaded into the seized IOB starting at offset X'28'. The hexadecimal values of the two mode-setting commands are:

   Continuous Refresh On: X'27aaaaaa 00000002'

Continuous Refresh Off: X'07aaaaaa 00000002'

(X'aaaaaa' is the address of a half-word in the host system that contains X'FFFF'.)

3. **Load the address of an Event Control Block**: The 4-byte address of an event control block (ECB) must be placed into the IOB starting at offset X'04'. The addressed ECB must contain X'00000000'.

4. **Invoke EXCP**: Load the address of the IOB into general register 1, and execute an SVC 0 instruction. Control then returns to the user program.

The seized IOB will automatically be released by GAM when the command has completed. At this point the ECB will be posted. The user should wait on the ECB for I/O completion, and check that the post code is X'7F' for normal completion.

Note: The action to be taken upon abnormal completion depends upon the user's application and the action of the error recovery program. Error recovery is addressed in *OS/VS Graphic Programming Services (GPS) for the IBM 2250 Display Unit and the IBM 3250 Graphics Display System*, GC27-6971, and in *OS/VS Problem Determination Aids and Messages and Codes for GPS and GSP*, GC27-6974.

System Compatibility

The modifications for continuous refresh have no dependencies on featured attachments or accessories; however, it may not be possible to make full use of the function, unless certain features are present. There is no check made that particular attachments exist.

The continuous refresh function:

- Is transparent to the IBM 3258 Channel Control Unit.
- Does not affect the functions of the 3250 I/O instructions.
- Is not affected by command chaining. Commands may be issued with individual start input/output instructions (SIOs) or as part of a chain, the result is functionally the same. When tuning an application to use continuous refresh mode, it may happen that either chaining or not chaining gives better performance.)
- Does not affect the functions of Selective Reset and System Reset. (If continuous refresh mode is on when either of these resets is received, regeneration ceases and continuous refresh mode terminates.)

Note: If an application program terminates with the 3251 in continuous refresh mode, the image may remain on the display screen. This image can be removed by temporarily powering-down the 3251; it does not require a reset of the 3255 Display Control Unit.

Appendix A. Channel Commands

This appendix lists the input/output channel commands that are valid for the 3250 Graphics Display System. Notes provide additional information concerning the implementation of specific commands when the addressed 3251 is capable of operating in continuous refresh mode.

Type of Command	Channel Command	Command Code	Notes
Write	Write Buffer	Hex 01	Notes 1, 6
Read	Read Buffer	Hex 02	Note 6
	Read Manual Input	Hex 0E	Note 2
	Read Cursor	Hex 06	Note 6
	Read X,Y Position registers	Hex 12	Notes 3, 6
Control	Control No-Operation	Hex 03	
	Set Buffer Address register and Start	Hex 27	Note 4
	Set Buffer Address register and Stop	Hex 07	Note 4
	Insert Cursor	Hex 0F	Note 6
	Remove Cursor	Hex 1F	Note 6
	Set Program Function indicators	Hex 1B	
	Set Audible Alarm	Hex 0B	
Sense	Sense	Hex 04	Note 5

Notes:

1. A Write Buffer channel command issued to a 3251 operating in continuous refresh mode is handled as a Batched Write command. The data transferred by a Batched Write Command must be formatted as a batched write record.

2. There is no change to the operation of Read Manual Input, except that new values may appear in the last two bytes of the Manual Input Register. A simulated keyboard interrupt, set by GSRTE, may be pending when the Read Manual Input command is processed; this causes the Manual Input Register to become "busy" again immediately.

3. When the addressed 3251 is operating in continuous refresh mode, the value returned in response to a Read X,Y Position Registers command is 4 bytes of X'00'. (This is the same as the response when the command is issued after a reset and before the beam has been moved.)

4. If the address operand is X'FFFF', the SBA commands set continuous refresh on (SBA and Start) or off (SBA and Stop). If the address operand is within the range of buffer addresses assigned to the 3251, the only change to the function of the SBA commands is that SBA and Stop issued to a 3251 operating in continuous refresh mode resets the buffer-running sense bit without terminating the buffer program.

Regardless of the current mode, Set Buffer Address Register and Start with a real address resets:

A pending Attention or Attention/Unit-Check

A stacked GSRTE-simulated Attention resulting from a GSRTE order attempting to set the manual input register while the register is busy pending the arrival of a Read Manual Input command from the host system.

5. The 3255 returns sense information upon request as usual. The buffer-running sense bit is set to match the last occurrence of a normal Set Buffer Address-type command or interrupt, regardless of the fact that regeneration may be continuing after a normal Set Buffer Address Register and Stop in continuous refresh mode.

6. In continuous refresh mode, bit 3 of the second sense byte is set on.

Buffer Program Termination

If the 3251 raises an Attention/Unit-Check interruption, the buffer program is terminated regardless of the current mode and the fact that the event is not always passed on to the host system. In this case the buffer-running bit accurately represents the state of the buffer - "stopped."

The Buffer Address Register value following a GEOS interrupt correctly reflects the odd/even nature of the last received Set Buffer Address-type command, although the Attention/Unit-Check may not be passed to the host system. In continuous refresh mode, transfer of control to an odd address prior to execution of an interrupt-raising GEOS or GPDI order may not be reflected in the low-order bit of the buffer address returned in the sense bytes. The sense bits defining the type of event causing an Attention/Unit-Check correctly show the event-type despite the fact that the interrupt is not presented to the host if the buffer-running sense bit is off when the event occurs.

These commands are accepted when regeneration is in progress, provided that the buffer-running sense bit is off.

Appendix B. Assembler Language Macros

The following assembler language macros may be used to generate the GSRTE and GTCT buffer orders. These macros are consistent with those supplied as part of the OS/VS Graphic Programming Services (GPS) and use some of the GPS service macros.

Note: The "addr" and "group" operands are the same as those used by the GPS macros that allow the specification of buffer addresses.

The syntax allowed by these macros is:

```
name   GSRTE {ENABLE | DISABLE}[,{END | PFK | CANCEL | TEST},addr
       [,group]]

name   GTCT  addr[,group],COUNT=count
```

Note: The "addr" and "group" operands are the same as those used by the GPS macros that allow the specification of buffer addresses.

GSRTE Macro

```
         MACRO
&NAME    GSRTE &KB,&TYPE,&ADDR,&GROUP  START REGEN TIMER EXTENDED
         GBLA  &IHBBLC
         LCLA  &HWORD
&NAME    IHBGAM2 10882
         AIF   (T'&KB EQ '0').NOKB
         AIF   ('&KB' EQ 'ENABLE').CHKTYPE
         AIF   ('&KB' EQ 'DISABLE').DISABLE
.NOKB MNOTE 4,'KEYBOARD ENABLEMENT INVALID - ''DISABLE'' ASSUMED'
.DISABLE ANOP
&HWORD   SETA  8
.CHKTYPE AIF   (T'&TYPE EQ '0').NOTYPE
&HWORD   SETA  &HWORD+4
         AIF   ('&TYPE' EQ 'END').ENDTYPE
         AIF   ('&TYPE' EQ 'PFK').PFKTYPE
         AIF   ('&TYPE' EQ 'CANCEL').CANCELT
         AIF   ('&TYPE' EQ 'TEST').GEN
         MNOTE 4,'TYPE INVALID - ''END'' ASSUMED'
.ENDTYPE ANOP
&HWORD   SETA  &HWORD+1
         AGO   .GEN
.PFKTYPE ANOP
&HWORD   SETA  &HWORD+3
         AGO   .GEN
.CANCELT ANOP
&HWORD   SETA  &HWORD+2
.GEN     IHBGAM1 &HWORD,&ADDR,&GROUP
         MEXIT
.NOTYPE  AIF   (T'&ADDR EQ '0').NOADDR
         MNOTE 4,'ADDRESS OPERAND IGNORED'
.NOADDR  DC    H'&HWORD'
&IHBBLC  SETA  &IHBBLC+2
         MEND
```

GTCT Macro

```
         MACRO
&NAME    GTCT  &ADDR,&GROUP,&COUNT=0   TRANSFER ON COUNT
         GBLA  &IHBBLC
&IHBBLC  SETA  &IHBBLC+2
&NAME    IHBGAM2 10881
         IHBGAM1 11003,&ADDR,&GROUP
         DC    XL2'&COUNT'
         MEND
```

Bibliography

Further information concerning the IBM 3250 Graphics Display System is contained in the following publications:
An Introduction to the IBM 3250 Graphics Display System; GA33-3035: This publication provides introductory information about the system, its attachment to a host system, and the available programming support.

IBM 3250 Graphics Display System Component Description; GA33-3037: This publication provides reference information for users of the 3250 system. The information is primarily intended to assist the user who is writing application programs for execution in the 3250 system and includes (1) a description of the facilities available to the programmer; (2) a definition of the buffer orders used by the 3250 system; and (3) an example buffer program with a description of some programming techniques.

OS/VS Graphic Programming Services (GPS) for the IBM 2250 Display Unit and the IBM 3250 Graphics Display System; GC27-6971: This publication describes macro instructions and routines for use with OS/VS to aid in writing assembler language programs that use the 3250. It also provides general programming information for the 3250. (See Note)

Note: The IBM 3250 Graphics Display System is compatible with the IBM 2250 Display Unit Model 3 apart from the differences described in Chapter 7 of *An Introduction to the IBM 3250 Graphics Display System*; GA33-3035. Any reference to the IBM 2250 Display Unit Model 3 in the above publications is pertinent also to the 3250 system.

OS/VS Problem Determination Aids and Messages and Codes for GPS and GSP, GC27-6974.

Index

IBM 3250 Graphics Display System:
Continuous Refresh
(RPQs 7J0024 and 7J0025)
Custom Feature User's Guide

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