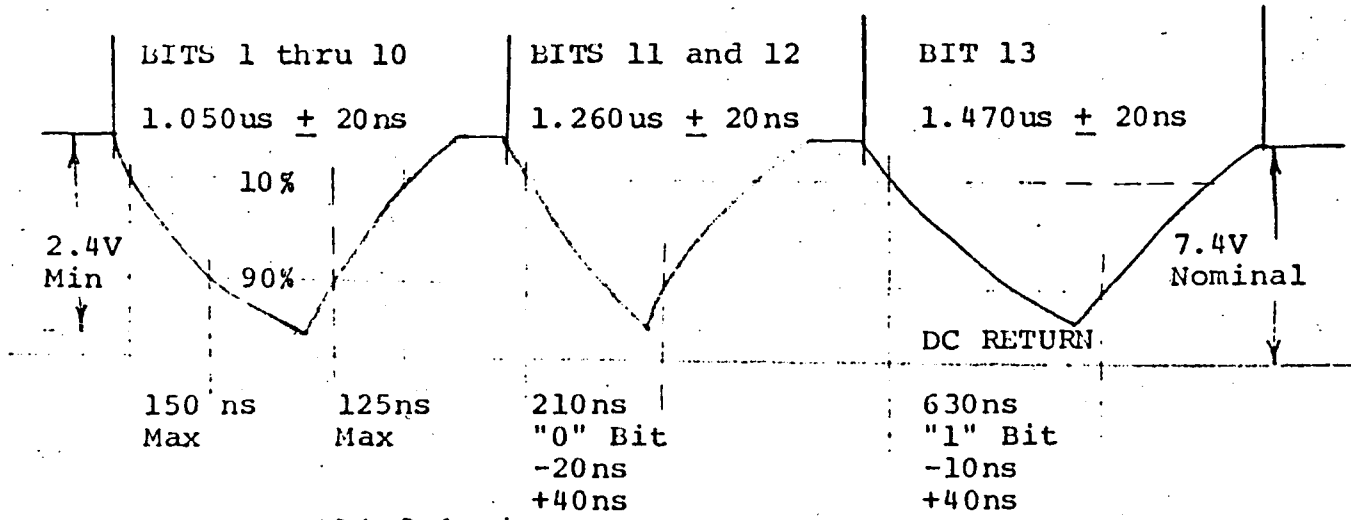_Mike Cowlishaw_

3271/2 CONTROL UNIT TO DEVICE INTERFACE

The 3271/2 Control unit (i.e., 3271 Mod 1, 2, 11, 12, or
3272 Mod 1 and 2) to Device (i.e., 3277 Mod 1, 2; 3284/6
Mod 1, 2; or 3288 Mod 2) interface is a single wire coaxial
cable interface (RG62AU Coax, Characteristic Impedance 93
Ohms) with serial by bit data transferred in either direction
but only one direction at a time. The Control Unit operates
as a master and the attached device as a slave. Each
device, attached directly to the Control Unit, receives
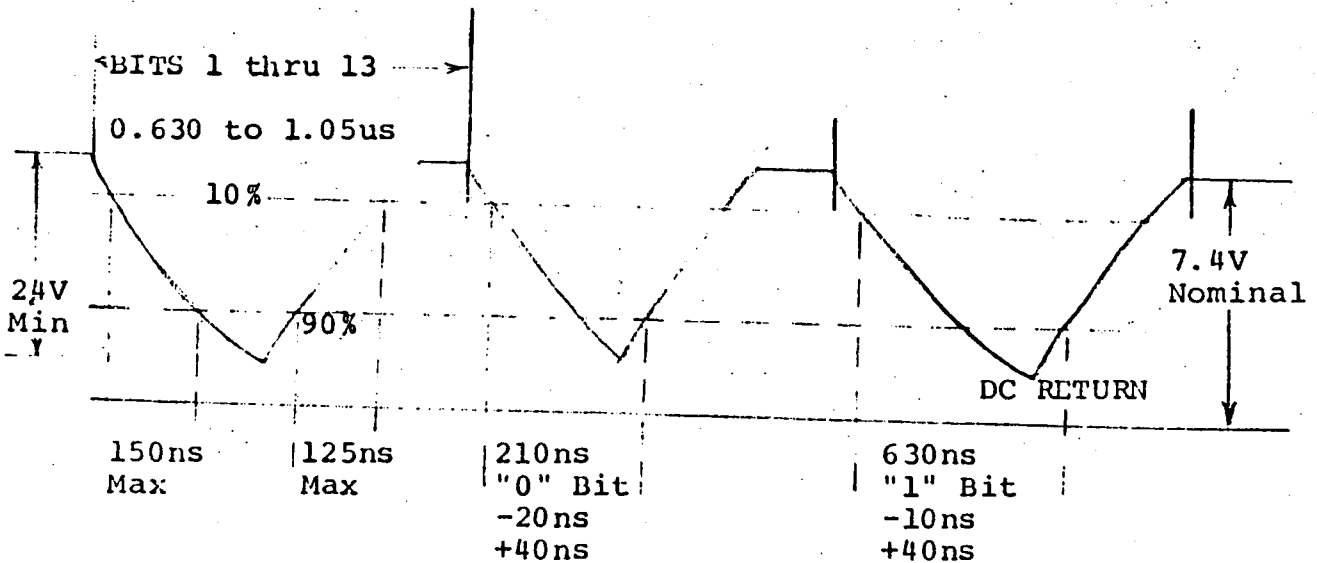and sends data addressed to that device only.

Bits on the coax appear as negative-going pulses. The
center conductor of the coax, when measured at the Con-
trol Unit with reference to the outer conductor (shield),
will be +7.4 volts nominal (5.2v min, 8.5v max) with no
signal present and power on at each unit. For maximum
coax cable length (2000 feet) the signal from the Control
Unit on the coax will appear as follows at the device:

[handwritten margin notes: half duplex 13Ω coax; 3277 slave]

BITS 1 thru 10	BITS 11 and 12	BIT 13
1.050us ± 20ns	1.260us ± 20ns	1.470us ± 20ns

10%

2.4V
Min

90%

7.4V
Nominal

DC RETURN

150 ns Max	125ns Max	210ns "0" Bit -20ns +40ns	630ns "1" Bit -10ns +40ns

[handwritten: strobe 210 + (630 - 210)/2]

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3271/2 CONTROL UNIT TO DEVICE INTERFACE

Bit timings from the Device to the Control Unit will meet

the same requirements as from Control Unit to Device

except for bit rate. The bit rate from the Device will

be 630ns min. to 1.050us max. per bit. The minimum duration

of the "Up" level after crossing the 10% point going in the

positive direction for a "one" or "zero" bit until the

start of the next consecutive bit will be 30ns.

BITS 1 thru 13

0.630 to 1.05us

10%

90%

24V Min

7.4V Nominal

DC RETURN

| 150ns Max | 125ns Max | 210ns "0" Bit -20ns +40ns | 630ns "1" Bit -10ns +40ns |

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The following conditions for the coaxial cable must be observed:

1) DC and frame ground are isolated (coax shield is DC return).

2) Fifteen cable splices maximum with compatible coaxial cable connectors. The outside of the connector is to be insulated by shrink fit tubing or equivalent to prevent accidental shorting to earth ground.

3) Inner conductor and outer shield of coax may be shorted without circuit damage at Control Unit or Device (Fault Condition).

4) A maximum of 20ma current may flow in the center conductor of the coax (Non-Short Condition) with power off at one end. (This current will not trigger Control Unit Receiver.)

5) Device power-up and down sequences must not introduce noise on the coax cable that may be interpreted as data regardless of validity.

6) Shield currents on the coax will not cause more than $\pm$ 20 ns pulse width modulation.

Up to 32 devices may be attached to one Control Unit.

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Since this sytem uses a master/slave communication method
between Control Unit and Device, a Polling sequence is used
to interrogate one Device at a time by the Control Unit to
determine the status of each attached Device. Sequential
Polling continues from Device to Device as determined by the
number of adapter cards installed in the Control Unit. One
adapter card provides the interface for four Devices. Each
Device position on an adapter card will be polled in sequence
irrespective of Device status (i.e., Device on and responding
with status, Device off and no response, or no Device attached).
This type of polling is referred to as "Idle Poll". Idle Polling
of Devices is continuous when the Control Unit is attached to
an operating System until the channel requests communication with
a specific Device or the poll response from the Device requires
System attention. At this point Idle Polling of all devices
stops, and the Control Unit selects and locks on to the addressed
Device. At the conclusion of communications between the Channel
and the addressed Device, Idle Polling will resume.

Serial bits sent across the coax cable between the Control
Unit and Device are assembled into 13-bit word groups at the
Device or Control Unit when received. The first bit of each

3271/2 CONTROL UNIT TO DEVICE INTERFACE

word is always a "one" (1) bit unless it is the first word sent from the Control Unit to Device of a series of words. This unique word will be all zero (0) bits and is used to condition the device input logic to receive all following communications with the Device until the selection is terminated. As each Device is selected by the CU during Idle Polling, the first 13 bits (all zeros) are followed directly by the Idle Poll word (13 Bits).

Polling is one of many command-type control words sent from a CU to a Device. Every control word sent to a Device must be received with good parity. If bad parity is detected by the Device, the Transmit Check Status Bit is set but no other function is performed at the Device. If a parity error is detected in a data stream as a result of the "Write" function, the word or words with bad parity are dropped and a null character is stored in place of each word containing bad parity and Transmit Check is set at the Device.

Two control words are required to contain all control-type functions directed to a selected Device by the Control Unit. Bit positions are assigned the functions as follows.

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CU CONTROL WORDS

Control Word Number 1

BUSY BIT	1	0	POLL	READ	WRITE	SYSTEM AVAIL	UNLOCK KEYBOARD	ERASE UNPROTECTED	RESET XMIT CK	ACK	PARITY	0
1	2	3	4	5	6	7	8	9	10	11	12	13

Control Word Number 2

BUSY BIT	1	1	POLL	(READ)	FORMAT		START PRINT	SOUND ALARM	RESET XMIT CK	SPARE	PARITY	0
1	2	3	4	5	6	7	8	9	10	11	12	13

Control Word Number 1 & 2:

Bits 4 and 5 set = "Read Poll"

Control Word Number 2

Bit 5 set without Bit 4 = SPARE

Bit combinations that may occur during normal operation (does not include combinations when running machine diagnostic programs) are:

Control Word 1:

Bits 4 and 5 set (read Poll) may include any combination of the following:

Bit 7, 8, 9, 10, and 11.

Bit 5 set (Read) may include bit 7

Bit 6 set (Write) may include bit 7

Bit 4 set (Poll) may include bit 11

Control Word 2: May include any combination of bits 4 thru 10

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Either or both words may be transmitted to a selected
Display or Printer.

Bit Meanings

1)   Busy Bit - Always a 1 bit

2)   Differentiates between control (=1) and data (=0) words.

3)   Differentiates between Control Word 1 (=0) and Control
        Word 2 (=1).

4)   Poll =1 - Causes Device to respond with status word and
        causes the Device to be released to operator inputs.

5)   CW #1 =1 - Read - Causes information transfer from
        Device to Control Unit.

4-5)   Read Poll =1 - Causes Device to respond with status word
        and locks out further operator inputs.
        CW #2 - Spare

6)   CW #1 =1 - Write - Signals Device that CU information is
        to be transferred to the Device.

7)   CW #1 =1 - System Available - Sent to the Device on a poll
        that lights System Ready indicator (if applicable).

3271/2 CONTROL UNIT TO DEVICE INTERFACE

6-7) CW #2 - Format - Specifies how the printed line will

appear.

Bits 6&7	=	0, 0	variable Line-Length Format, Up to 132 Char/Line
" "	=	0, 1	40 Char/Line Format
" "	=	1, 0	64 Char/Line Format
" "	=	1, 1	80 Char/Line Format

8) CW #1 =1 - Unlock Keyboard. Clears AID bits.

CW #2 =1 - Starts Print operation.

9) CW #1 =1 - Erase Unprotected command.

CW #2 =1 - Sounds Audible Alarm.

10) RESET XMIT CHK =1 - Sent to a Device to reset Transmit

Check Status Bit.

11) CW #1 =1 - ACK sent to a Device to reset Bit 6 (Info

Pending)

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CW #2 - Spare

12) Parity - Used to maintain ODD Parity on control and
data words (includes Bits 1 thru 12).

13) Always a zero in Control Unit control words.

When a poll is decoded at a Device with good parity, a status word is sent from the Device to the Control Unit to indicate any activity at the Device requiring System attention. Status words are of two types--depending upon the type of Device responding. These two status words are identified by being either a Display Status Word or a Printer Status Word.

Bit assignment of the Display Status Word is:

BUSY	0	DEV BUSY	DEV CHECK	TRANSMIT CHECK	INFO PENDING	AID*					PARITY	0/1
Bit 1	2	3	4	5	6	7	8	9	10	11	12	13

Bit assignment of the Printer Status Word is:

BUSY	1	DEV BUSY	DEV CHECK	TRANSMIT CHECK	INFO PENDING	NOT READY	SPARE	EQUIP CHECK	SPARE	SPARE	PARITY	0/1
Bit 1	2	3	4	5	6	7	8	9	10	11	12	13

*ATTENTION IDENTIFICATION CODE

HEX	SET BY:		HEX	SET BY:
00	NO AID GENERATED		13	PF 3 KEY
06	MAGNETIC CARD READER - ENTER		14	PF 4 KEY
09	RESERVED		15	PF 5 KEY
0A	RESERVED		16	PF 6 KEY
0B	PA 3 KEY		17	PF 7 KEY
0C	PA 1 KEY		18	PF 8 KEY
0D	CLEAR KEY		19	PF 90 KEY
0E	PA2 KEY (CANCEL)		1A	PF 10 KEY
			1B	PF 11 KEY
10	TEST REQ KEY		1C	PF 12 KEY
11	PF 1 KEY		1D	ENTER KEY
12	PF 2 KEY		1E	SELECTOR PEN

CHART 1

3271/2 CONTROL UNIT TO DEVICE INTERFACE

The following describes the purpose of each bit in these status words.

1) Busy Bit - Always a 1 bit.

2). Differentiates between Printer and Display Status Words.   0 = Display, 1 = Printer

3) Busy - Indicates that the Printer is printing or performing EAU function or that the Display is executing an internal function.

4) Device Check - Indicates that an internal Parity error or cursor check was detected by the Device.

5) Transmit Check - Indicates that the Device detected a Parity error in data (Control or Data Words) received from the Control Unit.

6) Info Pending -

    a) Display Status Word - Indicates Device Check or that an AID has been generated by the display station operator. Bits 7 through 11 will contain the AID. (See Chart 1.)

    b) Printer Status Word - Info Pending set if Device Check and/or Equipment Check is set.

7-11)   Display Status Word - Bits 7-11 contain the Attention Identifier (AID) that was originated at the display station.

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7) Printer Status Word - Not Ready indicates that the

Printer is out of paper and/or cover is open.

8) Printer Status Word - Spare

9) Printer Status Word - Equipment check indicates a

mechanical malfunction at the Printer.

10) Printer Status Word - Spare

11) Printer Status Word - Spare

12) Parity - Used to maintain ODD parity in Printer or

Display Status Words. (Includes Bits 1 thru 12).

13) Differentiates between Model 1 (=0) and 2 (=1)

Devices. (480 Character Device or 1920

Character Device respectively.)

The bit assignment of date words are:

Control Unit Data Word

Busy	0	Cursor	Data or Attributes	Parity	0
Bit 1	2	3	4 5 6 7 8 9 10 11	12	13

Device Data Word:

Busy	0	Cursor	Data or Attributes	Parity	0/1
Bit 1	2	3	4 5 6 7 8 9 10 11	12	13

3271/2 CONTROL UNIT TO DEVICE INTERFACE

1) Busy Bit - Always a 1 bit. Indicates first bit of an incoming word.

2) 0 - Set to 0 to indicate Data Word rather than Control Word.

3) Cursor - Cursor Position.

4-11) Data or attribute bits. When defined as data by Bit 4 = "0" Bit 5 is high order bit and Bit 11 is low order bit (See Chart 2 for Code). When defined as an attribute by Bit 4 = "1":

Bit 5 =   Spare

Bit 6 =   0 = Unprotected Field
           1 = Protected Field

Bit 7 =   0 = Alpha Field
           1 = Numeric Field

Bits 8&9= 00 = Normal Intensity - Non-Detect
           01 = Normal Intensity - Selector Pen Detect
           10 = High Intensity - Selector Pen Detect
           11 = Non-Display - Non-Print - Non-Detect

Bit 10=   Escape (Not Used)

Bit 11=   1 - Modified Data Tags for Previous Field

12) Parity - ODD parity, assigned by Sending unit. (Includes 1 thru 12).

13) 0/1 - Always 0, sent from a Control Unit.

   0 when sent from a 480 Character Device.

   1 when sent from a 1920 Character Device.

Four hundred and eighty data words are always sent to a Model 1 Device. Nineteen hundred and twenty data words are always sent to a Model 2 Device.

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Low Order Bits 8,9,10,11	Bit 5 Bits 6&7 Hex	High Order 0				High Order 1			
		00 / 0	01 / 1	10 / 2	11 / 3	00 / 4	01 / 5	10 / 6	11 / 7
0000	0	NUL				SP	&	-	0
0001	1	a	j			A	J	/	1
0010	2	b	k	s		B	K	S	2
0011	3	c	l	t		C	L	T	3
0100	4	d	m	u		D	M	U	4
0101	5	e	n	v	NL	E	N	V	5
0110	6	f	o	w		F	O	W	6
0111	7	g	p	x		G	P	X	7
1000	8	h	q	y		H	Q	Y	8
1001	9	i	r	z	EM	I	R	Z	9
1010	A					[	!		:
1011	B					.	$	,	#
1100	C		DUP			<	*	%	@
1101	D					(	)	_	'
1110	E		FM			+	;	>	=
1111	F					|	¬	?	"

Only those data characters shown within bold outline can be displayed and printed on the basic 3270 Lowercase alphabetic characters are displayed or printed as uppercase characters. Storage still retains all codes which were entered via Control Unit or Keyboard.

NL, EM, DUP, and FM Control Characters (uniquely stored) are displayed or printed as 5, 9, * and ; characters, respectively; except by the Printer under Format Control, in which case NL and EM do not result in a character being printed.

CHART 2

CONTROL WORD FUNCTION	RESULT AT SELECTED DEVICE	AT CU AS RECEIVED FROM DEVICE	TIMING CONCERN AT THE CU	THE DEVICE	EFFECT ON SYSTEM (SEE IBM PUBLICATION GA27-2749 - IBM 3270 IDS COMPONENT DESCRIPTION)
IDLE POLL	Respond with 13 Bit Status Word (Releases the Device to the Operator)	1) 13 Bit Status Word. No Error Conditions or Info Pending	Must Receive Status Word <40 us.*	None	None
		2) 13 Bit Status Word. Info Pending Set. Aid Code Set	"	"	Asynchronous Attention Status will be presented.
		3) 13 Bit Status Word. Bad Parity (1 Hardware Retry)	"	"	None
		13 Bit Status Word. Again Bad Parity	"	"	Asynchronous Attention plus Unit Check Status will be presented. Equipment Check will be presented as a response to next sense command.

*Includes all 13 Bits of Status Word at the CU.

| CONTROL WORD FUNCTION | RESULT | | TIMING CONCERN AT | | EFFECT ON SYSTEM (SEE IBM PUBLICATION GA27-2740 - IBM 3270 IDS COMPONENT DESCRIPTION) |
	AT SELECTED DEVICE	AT CU AS RECEIVED FROM DEVICE	THE CU	THE DEVICE	
IDLE POLL	Respond with 13 Bit Status Word (Releases the Device to the Operator)	4) 13 Bit Status Word. Info Pending Set. Device Check Set	Must Receive Status Word <40 us.*	None	Asynchronous Attention Unit Check will be presented. Data Check and Unit Specify will be presented as a response to the next sense command.
		5) 13 Bit Status Word. Device Busy Set	"	"	None
		6) 13 Bit Status Word. Transmit Check Set	"	"	None (Used only to verify correct transfer of data between CU and Device) on a Write.)
		7) 13 Bit Status Word. Not Ready Set or Info Pending and Equipment Check Set	"	"	See Referenced Publication

*Includes all 13 Bits of Status Word at the CU.

CONTROL WORD FUNCTION	RESULT		TIMING CONCERN AT		EFFECT ON SYSTEM (SEE IBM PUBLICATION GA27-2749 - IBM 3270 IDS COMPONENT DESCRIPTION)
	AT SELECTED DEVICE	AT CU AS RECEIVED FROM DEVICE	THE CU	THE DEVICE	
IDLE POLL	Power Off or Disconnected or No Response due to Malfunction	8) No Data Received	After 40to65us. a Retry of Idle Poll is made	None	None
		No Data Received Again	After 40 us. a Not Available Condition is Logged at the CU. Next Device is Polled	None	None
READ POLL See Special Conditions when following Write Function	Respond with 13 Bit Status Word (Locks out operator inputs) at a Display Unit	Same as #1	Must Receive Status Word 40 us.	Lock out Operator input before Poll response is sent from Device.	None
		Same as #2	"	"	None
		Same as #3 including Retry	"	"	A Channel End, Device End, Unit Check will be presented as ending status. (If CE had been sent in initial status, not sent at this time) Data check is sent as response to sense command

CONTROL WORD FUNCTION	RESULT AT SELECTED DEVICE	RESULT AT CU AS RECEIVED FROM DEVICE	TIMING CONCERN AT THE CU	TIMING CONCERN AT THE DEVICE	EFFECT ON SYSTEM (SEE IBM PUBLICATION GA27-2749 – IBM 3270 IDS COMPONENT DESCRIPTION)
POLL (READ) READ Bit will be set. See Special Conditions when following Write Function	Respond with 13 Bit Status Word (Locks out operator inputs at a Display Unit	Same as #4 (IDLE POLL)	Must Receive Status Word <40 us.	Lock out Operator inputs before Poll response is sent from Device.	A Channel End, Device End, Unit Check will be presented as ending status. (If CE had been sent in initial status, not sent at this time) Data Check is sent as response to sense command. Sense response will also include Unit Specify
		Same as #5	"	"	Same as above--except for Unit Exception not UC. No sense command
		Same as #6	"	"	None
		Same as #7	"	"	See Referenced Publication
	POWER OFF or No Response	Same as #8	Same as Idle Poll #8--except next Device is not polled until command is complete and Idle Polling resumes	"	Ending status will be presented as Channel End, Device End, and Unit Check, Sense will Control Check

| | RESULT | | TIMING CONCERN AT | | EFFECT ON SYSTEM |
CONTROL WORD FUNCTION	AT SELECTED DEVICE	AT CU AS RECEIVED FROM DEVICE	THE CU	THE DEVICE	(SEE IBM PUBLICATION GA27-2749 - IBM 3270 IDS COMPONENT DESCRIPTION)
READ	Send 480 or 1920 Bytes of Data to Control Unit	480 or 1920 Bytes of Data	Failure of previous Item on Retry	None	Ending status will be presented as Channel End, Device End, and Unit Check, Sense will present Control Check.
		If Bad Parity Retry Again Bad Parity received	"	None	Ending status will be presented as Channel End, Device End, and Unit Check, Sense will present Data Check
WRITE	Clear if set: Transmit check Bit & Device Check Bit	No response to CU	None	First Data Word will follow the WRITE Function Control Word in no greater than 40 us Maximum time between Data Bytes is 40 us Minimum time will be con- secutive Bits (Bit 1 following Bit 13 of pre- vious Byte) A Poll (READ) will be received at the Device in no more than 40 us after the last Data Byte	None

| CONTROL WORD FUNCTION | RESULT | | TIMING CONCERN AT | | EFFECT ON SYSTEM (SEE IBM PUBLICATION GA27-2749 - IBM 3270 IDS COMPONENT DESCRIPTION) |
	AT SELECTED DEVICE	AT CU AS RECEIVED FROM DEVICE	THE CU	THE DEVICE	
POLL (READ) Directly following WRITE	Respond with 13 Bit Status Word	Same as for Poll (READ) -- except If Transmit Check is set a Rewrite is performed After Rewrite Transmit Check is set again.	Same as Idle Poll #8 except next Device is not polled until command is complete and Idle Polling resumes	Lock out Operator inputs before Poll response is sent from Device.	Ending status will be presented as Unit Check, Channel End, and Device End, Sense will present Data Check, Unit Specify
READ	Send 480 or 1920 Bytes of Data to Control Unit from storage	480 or 1920 Bytes of Data	Must receive first Data Word <80 ms. Time between Data Bytes must not exceed 40 us. If failure of either a Retry is performed	None	None for successful READ

CONTROL WORD FUNCTION	RESULT		TIMING CONCERN AT		EFFECT ON SYSTEM (SEE IBM PUBLICATION GA27-2749 - IBM 3270 IDS COMPONENT DESCRIPTION)
	AT SELECTED DEVICE	AT CU AS RECEIVED FROM DEVICE	THE CU	THE DEVICE	
SYSTEM AVAILABLE	Will only be received with a Poll (READ) Turns on System Available Indicator	No response to CU	None	None	None
UNLOCK KEYBOARD	Unlocks Keyboard CLears AID Code	No response to CU	None	None	None
Erase unprotected (Poll, Read, and System Available Bits also set)	Erase all Unprotected fields in Device Storage. Clear all Modified Data Tags to Ø's. Lock Keyboard until complete--then unlock and clears AID Code	CU continues to Poll Device until Busy Indication is no longer present.	Busy In Status Word must be received in <40 us but not be present after 80 ms	None	None
RESET TRANSMIT CHECK	Clears Transmit Check	No response to CU	None	Must be clear before next poll received	None

CONTROL WORD FUNCTION	RESULT		TIMING CONCERN AT		EFFECT ON SYSTEM (SEE IBM PUBLICATION GA27-2749 – IBM 3270 IDS COMPONENT DESCRIPTION)
	AT SELECTED DEVICE	AT CU AS RECEIVED FROM DEVICE	THE CU	THE DEVICE	
ACKNOWLEDGE (ACK)	Clears the Information Pending Latch	No response to CU	None	Info Pending Latch must be clear before next Poll received.	None
FORMAT	Controls Format of the Printer as indicated by the two Format Bits	No response to CU	None	Activate proper Format Control Logic of Printer prior to Start of Print Function	None
START PRINT	Start physical printout of Printer Storage as defined by Format.	No response to CU	None	Must respond in Status Word with Busy in no more than 40 us. if Poll Bit also set	None
SOUND ALARM	Sound Audible Alarm at Device if applicable	No response to CU	None	None	None