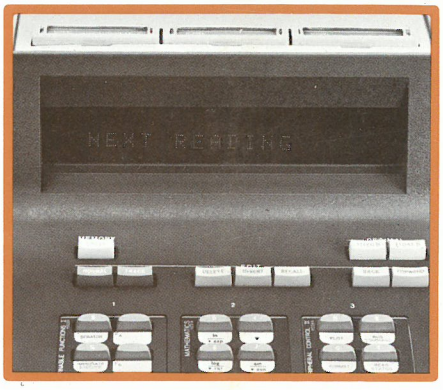
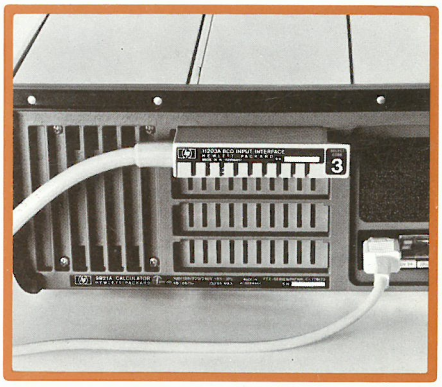
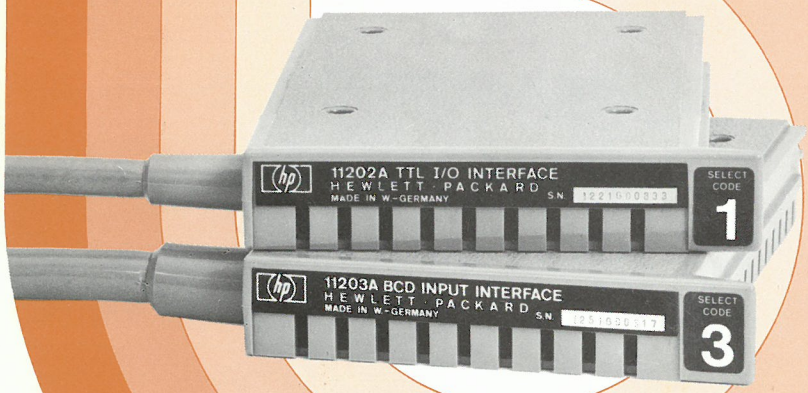




DESIGNERS' GUIDE TO INTERFACING



HEWLETT hp PACKARD

PREFACE

This guide contains information to enable you to interface your device, by an 11202A or 11203A interface card, to a 9800-Series calculator.

The guide begins with some general information about the interface cards and the calculator. The diagrams and check-list in section 2 are to help you choose the right interface card. Once you have decided which interface card is the right one for your device, you can refer to the relevant section.

Appendices at the rear of the guide give other information that you may find useful when interfacing your device.

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SECTION 1

GENERAL INFORMATION

INTRODUCTION

To interface your device to a 9800-Series calculator you require hardware and software. The 11202A and 11203A interface cards fulfil the hardware requirements; Read-Only-Memories (ROMs) fulfil the software requirements.

INTERFACE CARD SPECIFICATIONS

Although different in function, the 11202A and 11203A are the same in appearance and require the same operation environment. The following information is relevant to both interface cards.

Dimensions (case): 12,06 cm x 15,87 cm (4,75 in. x 6,25 in.).

Cable (unterminated): 182 cm (72 in.)

Temperature Range: 0°C to 45°C ambient

Power: Provided by the calculator.

Select Code: Set at the factory to 1 for 11202A and 3 for 11203A. Select code 1 through 9 selectable (see section 'Setting the Select Code').

NOTE: Other devices must not be supplied by the interface card's +5V.

SETTING THE SELECT CODE

Since all peripheral devices are connected to the calculator in a party-line fashion, each device must have a unique address so that the calculator can specify which device must respond to each operation. This address, or 'select code', consists of a one-digit number and is preset on the interface card.

Although the 11202A is set to respond to select code 1 and the 11203A interface card is set to respond to select code 3 when supplied, you can set any one of eight other codes 1 through 9 by following this procedure:

- Switch the calculator and the peripheral device OFF.
- Disconnect the interface from the calculator. Remove the four screws located on the top of the card assembly. Then turn the card over and lift off the bottom cover.
- Locate the select code switch (see figure 1—1). Raise the hinged cover on the switch. Using a small, flat-blade screwdriver, carefully rotate the selector-tab until it is positioned at the desired select code number. Numbers are printed on the side and on the top cover of the switch ('0' is unusable). Before closing the cover, be sure the slot in the selector-tab is at a right angle to the length of the switch.

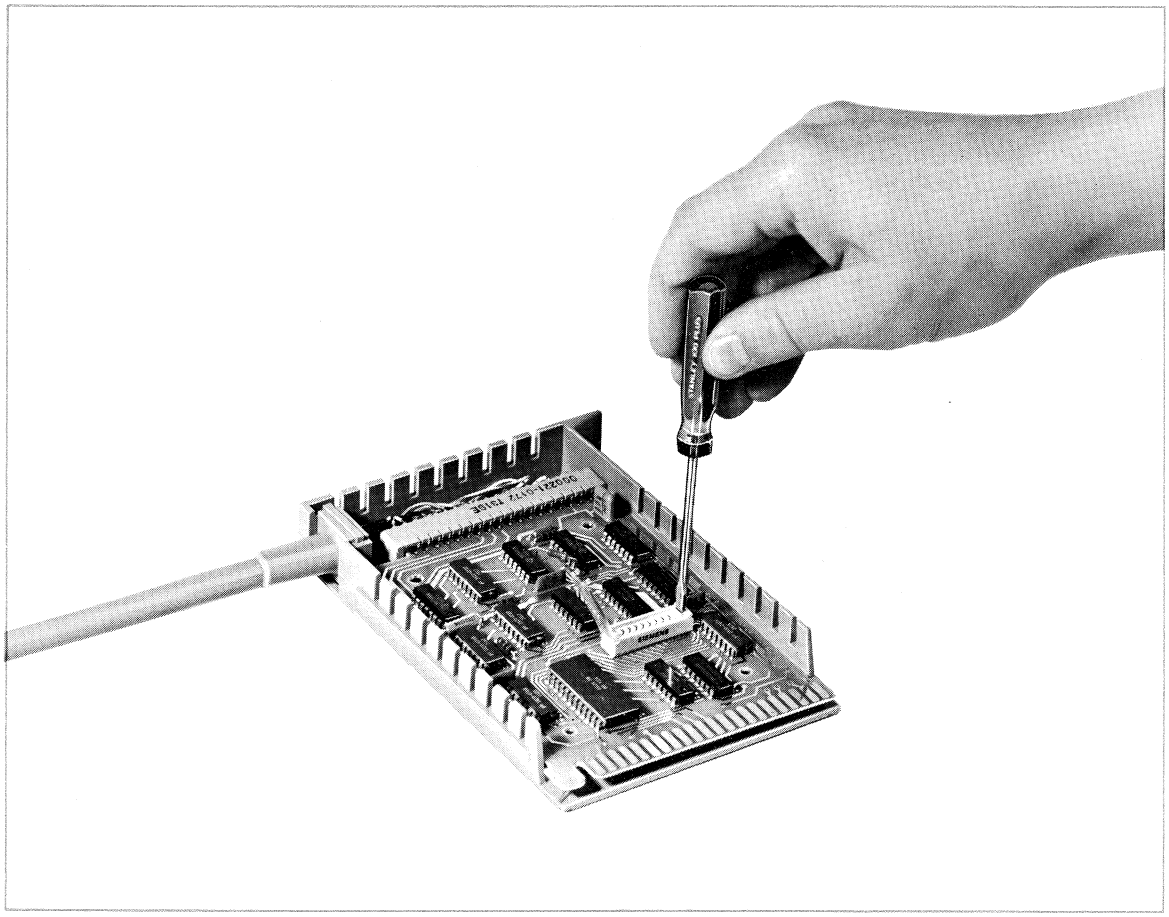


Figure 1—1. Setting the Select Code

READ-ONLY-MEMORY (ROM)

Before the calculator can drive the 11202A or 11203A the correct ROM must be installed in the calculator.

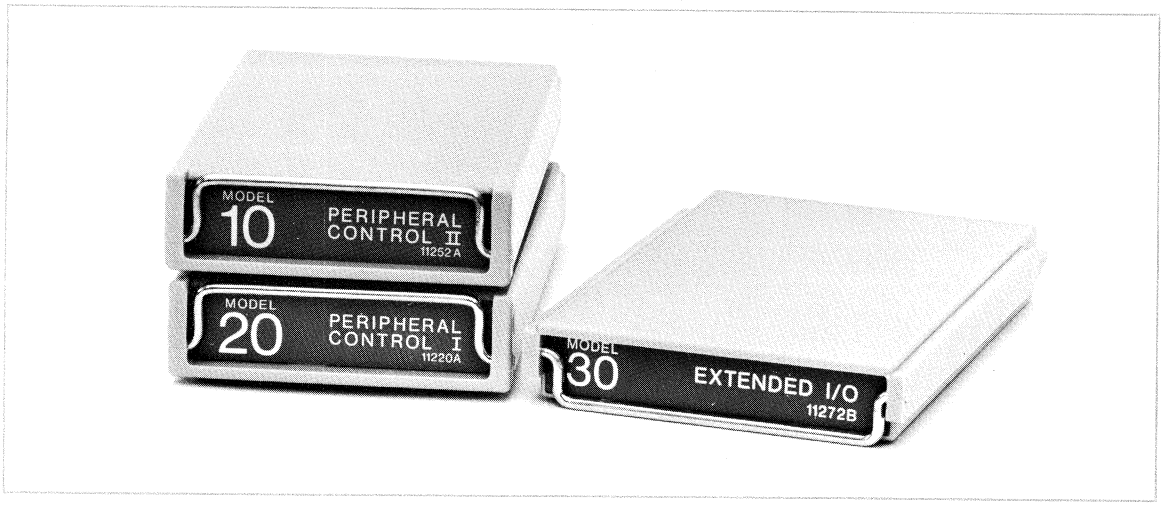


Figure 1–2. Read-Only-Memory (ROM)

The ROM you install will depend on which 9800-Series calculator you have, the type of functions you wish the calculator to do and what other (if any) peripherals you want to use with the calculator.

The following table is a guide to help you choose the most suitable ROM for your needs.

Table 1–1. ROMs

Calculator	9810	9820/9821	9830
ROM	11264A*	11220A	not applicable
PCI	Input numeric values Output numeric values Message output	Input numeric values Output numeric values Message output	
PCII	11252A Input numeric values Output numeric values Message output Read Read status Binary arithmetic Special memory manipulation	11224A Input numeric values Output numeric values Message output Read byte Read status HP Interface Bus Commands	not applicable
NO ROM	not applicable	not applicable	Write Print
Extended I/O	not applicable	not applicable	11272B Enter Output Read byte Write byte Read status HP Interface Bus Commands Binary arithmetic

For more information about the ROMs refer to the ROM Manual (see Bibliography). *In addition to the 11264A ROM, two other ROMs that can be used with the 9810 calculator are, 11262A PC/Cassette Recorder and 11266A PC/Printer-Alpha combination ROMs — these do all the functions of the PCI ROM plus drive the relevant peripherals.

CALCULATOR INPUT/OUTPUT LINES

Here is a brief description of the calculator's input/output lines. The lines are accessed by simply plugging the interface card into any of the slots in the rear of the calculator.

A bar (—) above a line name indicates that the line goes low (0 volts) when pulsed '1'. All other lines go high (> 2.4 volts) when pulsed '1'.

CO0
CO1
CO2
CO3
} Peripheral Address Lines. Used to select correct device. (The address must correspond to the select code set in the interface card).

$\overline{CEO}$ — Control Enable Line. Provides correct timing for interface operations.

$\overline{DI0}$
$\overline{DI1}$
$\overline{DI2}$
$\overline{DI3}$
$\overline{DI4}$
$\overline{DI5}$
$\overline{DI6}$
$\overline{DI7}$
} Calculator Data Input Lines.

DO0
DO1
DO2
DO3
DO4
DO5
DO6
DO7
} Calculator Data Output lines (applicable only to 11202A).

SI0 — Indicates ready/busy status of the interface (BUSY = 1).

$\overline{SIH}$ — Calculator Service Inhibit Line. A continuous clock, which when low indicates calculator input outpur operations.

SO3 — Applicable only to 11202A. Calculator Status Line. Indicates whether the calculator wants to input or output data (INPUT = 1).

$\overline{STP}$ — Calculator Stop Line. Goes low when STOP key is pressed. STP terminates all I/O operations.

WIRE COLOUR CODES

The colour coding that is used on the logic diagrams is as follows:

0 – Black
1 – Brown
2 – Red
3 – Orange
4 – Yellow
5 – Green
6 – Blue
7 – Violet
8 – Grey
9 – White

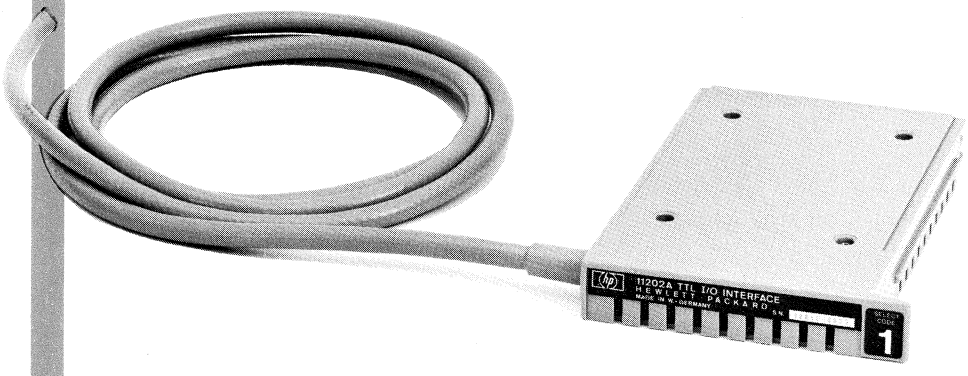
This is the same sequence as is used for resistor colour-coding.

For multicoloured wires, the first number identifies the base colour, the second number identifies the wider strip and the third number identifies the narrower strip (e. g. 9 2 4 = white, red, yellow).

YOUR REQUIREMENTS	11202A	11203A
You want to output data from your device	☒	☒
You want to input data to your device	☒	☐
Your devices uses TTL logic levels	☒	☒
Your device has negative-true logic	☒	☒
Your device has positive-true logic	☐	☒
Your device handles 8-bit (or less) parallel/character serial data	☒	☐
Your device handles 8421 BCD code	☐	☒
Your device responds to a control signal	☒	☒
Your device generates a ready/busy (flag) signal	☒	☒

By considering these points you can find which card you need to interface your device to a 9800-Series calculator. For example, if you want to be able to input and output data, only the 11202A is suitable, whereas, if you only want to input data both the 11202A and 11203A are suitable.

11202A I/O INTERFACE CARD



SECTION 3

11202 I/O INTERFACE CARD

INTRODUCTION

The 11202A I/O interface provides an 8-bit data exchange between a 9800-Series calculator and a peripheral device. The interface transfers data in the half-duplex mode (i.e. either sends or receives data, but not both at the same time), one 8-bit character at time.

The interface card stores each input or output data character. To control the data transfer, the interface card has a control line and a data ready/accept line (flag line).

All data and control lines are compatible with transistor, transistor logic (TTL) levels ($< 0.7V$ to $> 2.4V$) and use negative-true logic.

The calculator must have, at all times, control over data transfer operations between your device and the calculator. The calculator does this with the CTL and FLG lines.

CONNECTING YOUR DEVICE

The circuit diagram at the rear of this section should be referred to while reading this section.

DATA INPUT LINES

These transfer data from your device to the calculator. They must be connected to your device's output lines (input 1 to output 1, input 2 to output 2, etc.).

The calculator has eight input lines, IØ through I7. Any data input lines not used must be left open.

Mnemonic		Interface Card Connector Pin Number	Wire Colour (Colour Code)	
IØ	(least significant bit)	16	Black	(Ø)
I1		15	Brown	(1)
I2		14	Red	(2)
I3		13	Orange	(3)
I4		12	Yellow	(4)
I5		11	Green	(5)
I6		10	Blue	(6)
I7	(most significant bit)	9	Violet	(7)

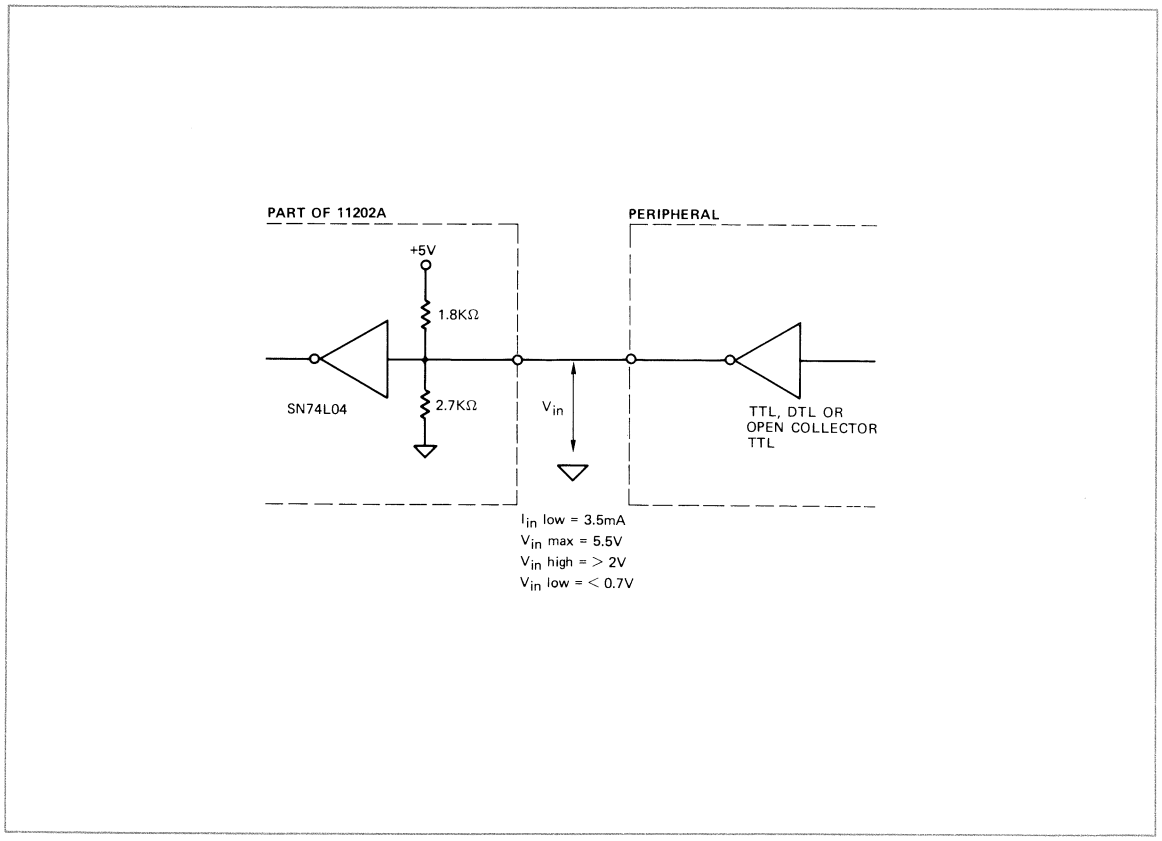


Figure 3–1. Recommended Data Input Line Circuit

DATA OUTPUT LINES

These transfer data from the calculator to your device. They must be connected to your device's input lines (output 1 to input 1, output 2 to input 2, etc.).

The calculator has eight output lines, OØ through O7. Any data output lines not used must be left open.

Mnemonic	Interface Card Connector Pin Number	Wire Colour (Colour Code)
OØ (least significant bit)	T	White/Black (9Ø)
O1	S	White/Brown (91)
O2	R	White/Red (92)
O3	P	White/Orange (93)
O4	N	White/Yellow (94)
O5	M	White/Blue (95)
O6	L	White/Green (96)
O7 (most significant bit)	K	White/Violet (97)

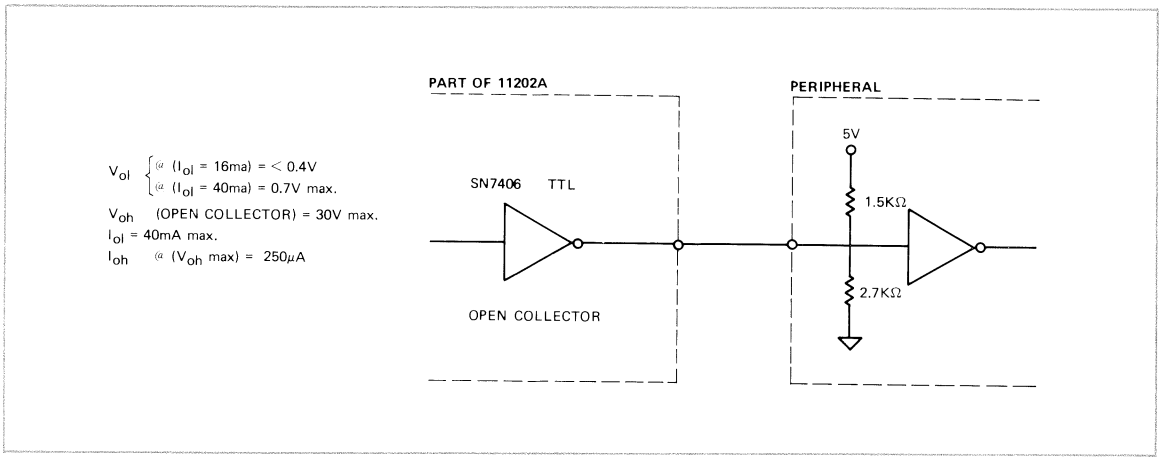


Figure 3–2. Recommended Data Output Line Circuit

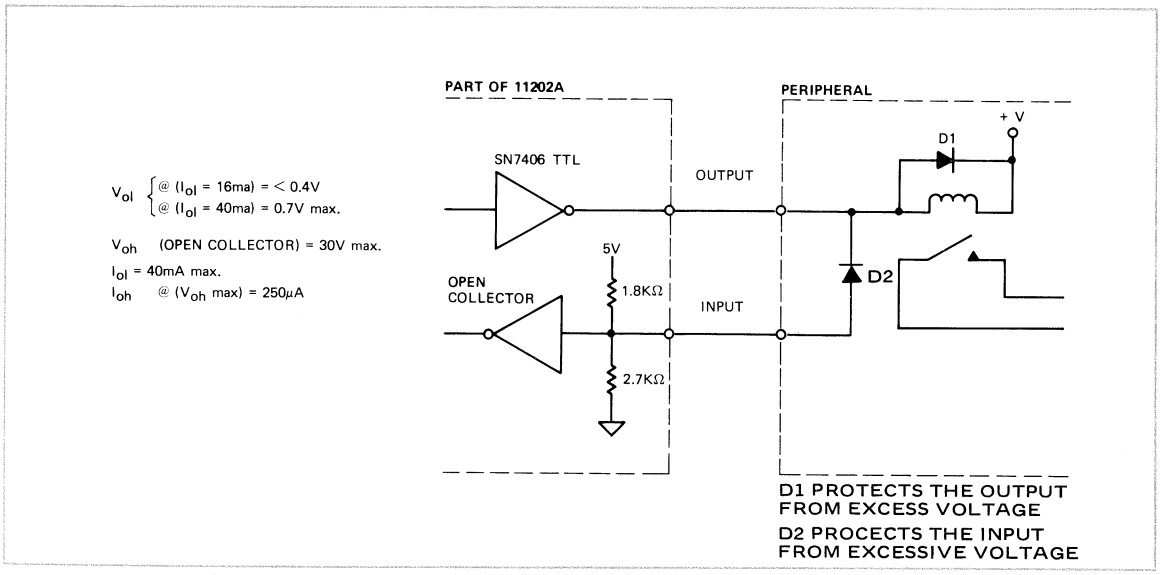


Figure 3–3. Typical Circuit for Controlling Relays

CONTROL LINE (CTL)

The CTL signal comes from the interface card to your device, and the line must be connected to a line in your device which will initiate data transfers (i.e. will cause your device to either output data to the calculator or receive data from the calculator).

Mnemonic	Interface Card Connector Pin Number	Wire Colour (Colour Code)
$\overline{CTL}$	H	White/Grey (98)

High-to-low transition indicates that the interface card is ready to receive data from your device or has data to send to your device.

The recommended circuit is the same as for data output (refer figure 3–2).

FLAG LINE (FLG)

The FLG signal goes from your device to the interface card and the line must be connected to the line in your device which will indicate to the calculator that it has accepted data from the calculator or has data to transmit to the calculator.

Mnemonic	Interface Card Connector Pin Number	Colour Wire (Colour Code)
$\overline{FLG}$	C	Grey (8)

Your device must indicate 'data accepted' or 'data valid' by forcing this line low. The FLG signal must be greater in duration than 500ns.

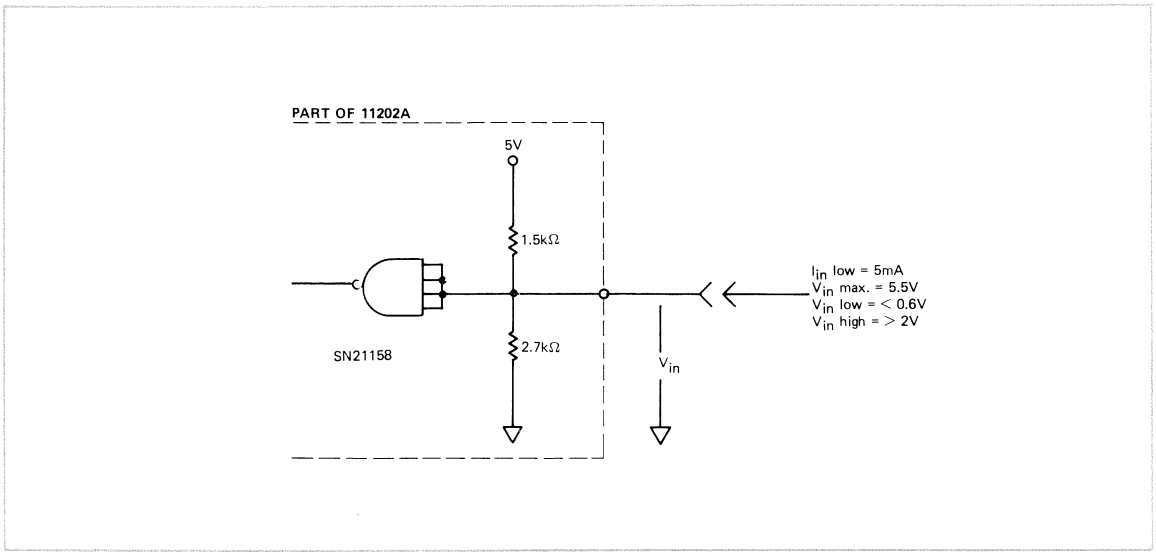


Figure 3–4. Recommended Flag Receiver Circuit

ENABLE CORPORATE HANDSHAKE LINE (ECH)

This line must not be connected to your device. This line must be either left open or grounded. When ECH is connected to ground, the interface card cannot force CTL low until your device forces FLG high (to indicate 'ready'). When ECH is left open, the interface card does not check the FLG line before forcing CTL low. For more information refer to Appendix 2.

Mnemonic	Interface Card Connector Pin Number	Wire Colour (Colour Code)
$\overline{\text{ECH}}$	B	White (9)

INPUT / OUTPUT LINE (I/O)

The use of this line is arbitrary. The I/O signal comes from the interface card to your device, and when the line is used it must be connected to a line in your device which will cause your device to execute either an input or output operation: high if the calculator is inputting data, low if the calculator is outputting data.

Mnemonic	Interface Card Connector Pin Number	Wire Colour (Colour Code)
I/O	F	White/Black/Brown (901)

STOP LINE (STP)

The use of this line is arbitrary. If this line is used it must be connected to a line from your device which when activated will stop your device from accepting data from the calculator or sending data to the calculator.

Pressing the STOP key on the calculator causes this line to go low and also stops the program in the calculator.

Mnemonic	Interface Card Connector Pin Number	Wire Colour (Colour Code)
$\overline{\text{STP}}$	J	White/Black/Red (902)

GROUND LINES (GND)

The ground from your device must be connected to one of these lines.

Mnemonic	Interface Card Connector Pin Number	Wire Colour (Colour Code)
	U V 18 17	White/Black/Orange (903) White/Black/Yellow (904)

THEORY OF OPERATION

In general, the 11202A is an 8-bit, bi-directional data buffer. Although the interface has separate input and output lines, it handles data in only one direction at a time. The SO3 signal determines whether the input or output mode is set.

A simplified block diagram of the interface is shown below.

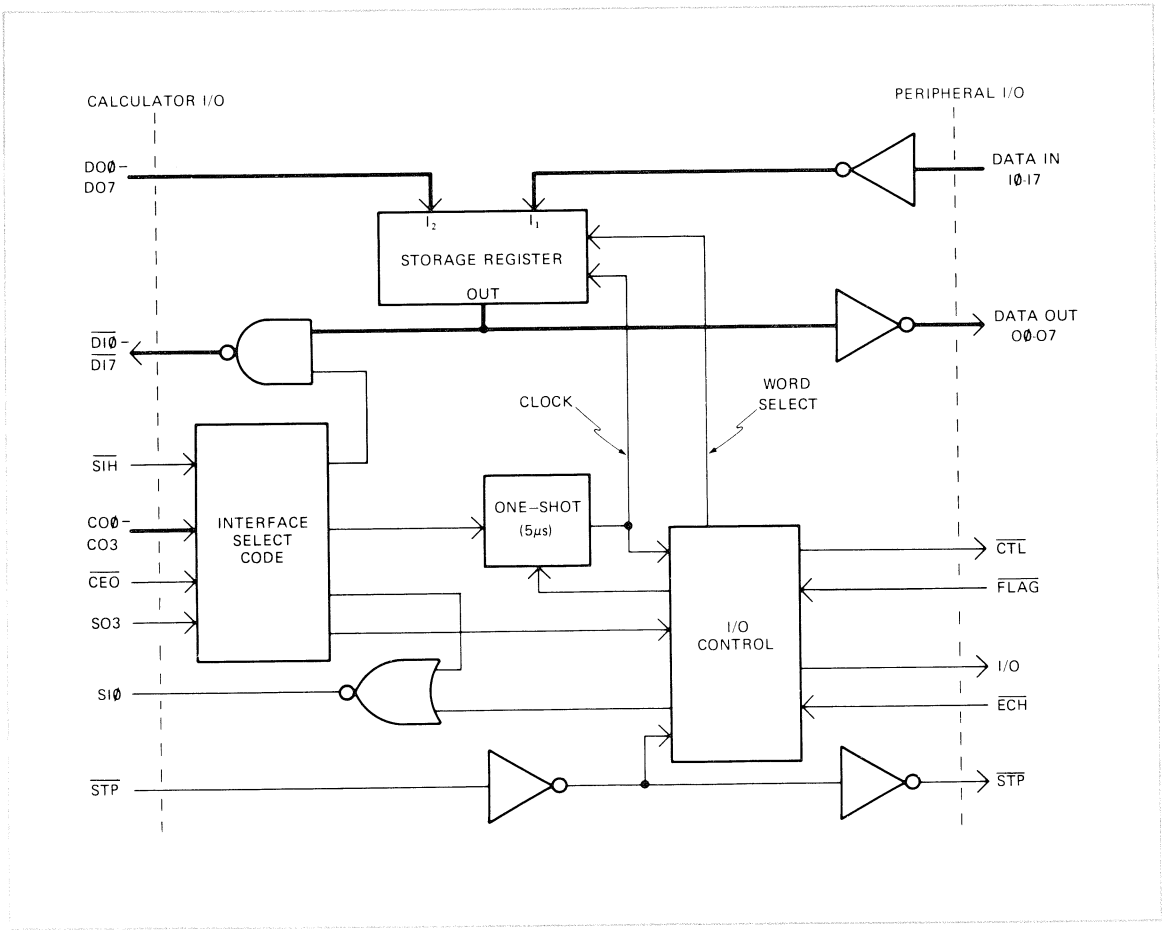


Figure 3–5. 11202A Interface Card – Simplified Block Diagram

DATA OUTPUT SEQUENCE

This sequence occurs each time the calculator outputs a character. The three following examples show a very simple key sequence for outputting data from the 9800-Series calculators (in the example the data is 25.72).

9810
PRESS: 2 5 . 7 2 FMT 4 select code PRINT SPACE

9820/21
PRESS: WRT select code 25.72 EXC

9830
PRESS: WRITE select code 25.72 EXC

- After an appropriate OUTPUT command or WRITE statement is executed from the calculator, a Select Code signal is output.
- The calculator checks interface status on the SI0 line. If the interface is not busy, data is held on the calculator output lines (DOØ–DO7) and an SO3 signal sets the I/O line low to indicate that a data-output operation has started.
- A $\overline{CEO}$ and a Select Code signal are output. If the Select Code signal corresponds to the setting of S1, data is transferred to the interface output lines. Thus later, the $\overline{CTL}$ line is forced low.
- Data is held on the output until your device indicates 'done' by forcing $\overline{FLG}$ low. Then data on the interface input lines is loaded into the storage register and onto the output lines.

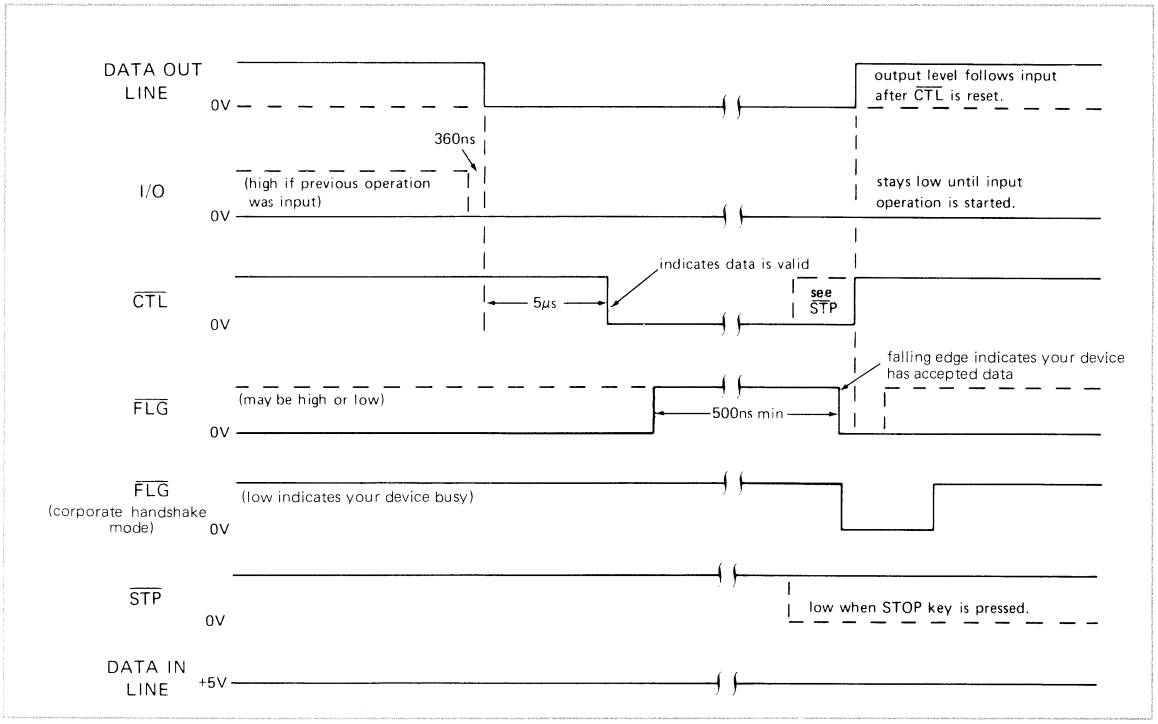


Figure 3–6. 11202A Data Output Sequence

DATA INPUT SEQUENCE

This sequence occurs each time the calculator inputs a character. The three following key sequences show how to initate an input operation.

9810: FMT 3 select code

9820/21: RED select code register (only possible in program mode)

9830: ENTER select code variables

- After an INPUT statement or READ statement is executed from the calculator, a Select Code signal is output.
- The calculator checks interface status on the SI0 line. If the interface is not busy, and SO3 signal sets the I/O line high to indicate that a data-input operation has started.
- The calculator outputs $\overline{CEO}$ and Select Code signals. If the Select Code signal corresponds to the setting of S1, the $\overline{CTL}$ line is forced low. Now the calculator monitors the SIØ line, waiting until your device has output data and indicated 'done' by forcing the $\overline{FLG}$ line low. 300ns later, data is loaded into the interface card and transferred to its output lines.
- The interface card then forces the SIØ line low and the calculator inputs the data on the next SIH pulse.

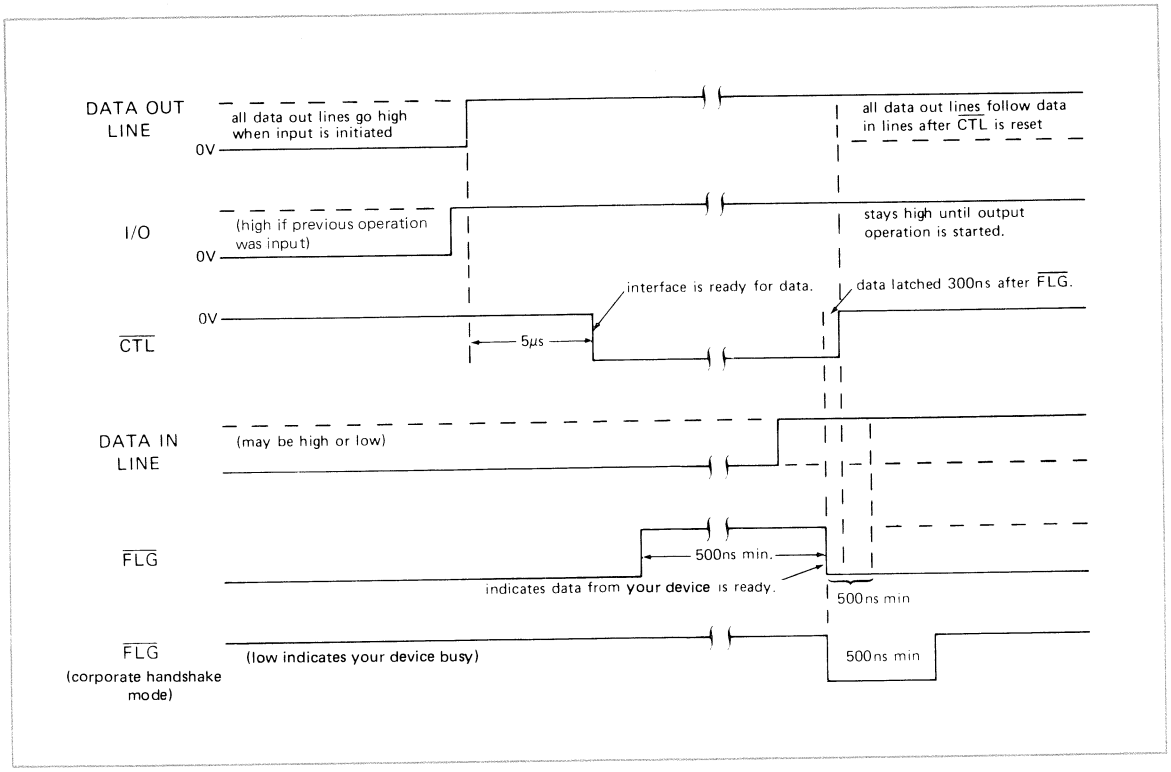


Figure 3–7. 11202A Data Input Sequence

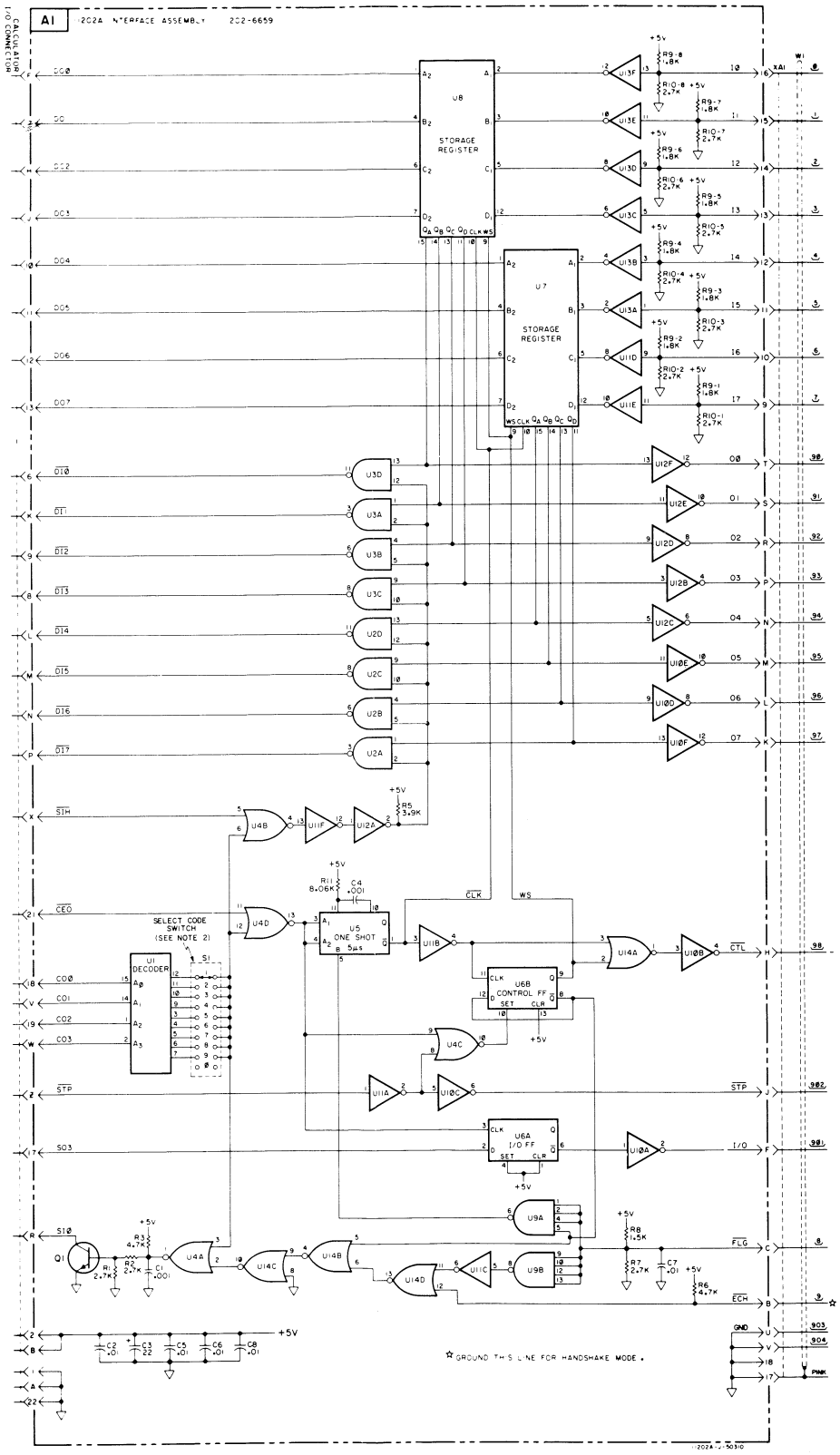


Figure 3–8. 11202A Circuit Diagram

11203A BCD INTERFACE CARD

SECTION 4

11203A BCD INTERFACE CARD

INTRODUCTION

The HP 11203A BCD interface card provides a 9800-Series calculator with an interface to a variety of instruments that have parallel Binary Coded Decimal (BCD) outputs (see Appendix 4). The interface is normally connected to the 'Digital Recorder' output of a BCD measurements device such as a digital voltmeter or frequency counter. When an appropriate Peripheral Control Block or Extended I/O ROM is used, the interface can transfer up to nine BCD digits of data and also function, range, sign, and overload information to the calculator.

All data and control lines are compatible with standard TTL levels. ($< 0.7V$ to $> 2.4V$).

SETTING NEGATIVE- OR POSITIVE-TRUE LOGIC

The 11203A interface card can be wired for positive-true or negative-true logic (refer Appendix 1). The 11203A leaves the factory wired for positive-true logic. To set the card to negative-true logic the appropriate resistors, distinguished by a + and — sign on the board, must be connected to the point marked by a (—).

To reselect positive-true logic, connect the appropriate resistors to the points marked by a (+).

All data lines, control lines and flag lines can be set, independent of each other, to positive-true or negative-true.

This table shows which resistors to change.

Lines	resistors to change
Data lines	R7 through R14, R16 through R20 and the reference line*
Control line 1	R3
Control line 2	R2
Flag Line	R1

*Reference Lines: When you select negative-true logic connect pin 4B to 3B (ground) and leave pin 6B open-circuit. When you select positive-true logic, connect pin 6B to 7B (ground) and leave pin 4B open-circuit.

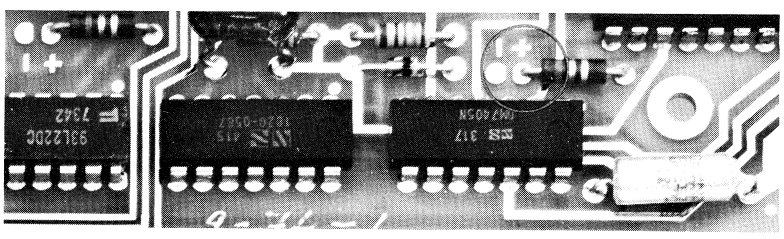


Figure 4—1. Setting Positive- and Negative-Logic

DATA LINES

These must be connected to the corresponding data lines in your device (i.e. the interface card's least significant digit (LSD), digit 9, to your device's LSD, etc.). Data lines not used must be connected to logic 0.

The data lines comprise, Digit 1 through Digit 9, Function Digit, Exponent Digit, Polarity, Exponent Sign, Exponent and Overload. Refer to circuit diagram at the rear of this section .

Mnemonic	Data Item	Interface Connector Pin Number	BCD	Wire Colour (Colour Code)
D1–8	Digit 1 – Most Significant Digit (MSD)	23B	8	White/Yellow/Blue (946)
D1–4		18B	4	White/Orange/Green (935)
D1–2		13B	2	White/Red/Blue (926)
D1–1		8B	1	White/Brown/Grey (918)
D2–8	Digit 2	24B	8	White/Yellow/Violet (947)
D2–4		19B	4	White/Orange/Blue (936)
D2–2		14B	2	White/Red/Violet (927)
D2–1		9B	1	White/Red/Orange (923)
D3–8	Digit 3	25B	8	White/Yellow/Grey (948)
D3–4		20B	4	White/Orange/Violet (937)
D3–2		15B	2	White/Red/Grey (928)
D3–1		10B	1	White/Red/Yellow (924)
D4–8	Digit 4	26B	8	White/Green/Blue (956)
D4–4		21B	4	White/Orange/Grey (938)
D4–2		16B	2	White/Orange/Yellow (934)
D4–1		11B	1	White/Red/Green (925)
D5–8	Digit 5	28A	8	White/Brown/Red (912)
D5–4		21A	4	White/Black/Red (902)
D5–2		12A	2	White/Brown (91)
D5–1		6A	1	Green (5)
D6–8	Digit 6	23A	8	White/Black/Yellow (904)
D6–4		14A	4	White/Orange (93)
D6–2		8A	2	Violet (7)
D6–1		5A	1	Yellow (4)
D7–8	Digit 7	24A	8	White/Black/Green (905)
D7–4		15A	4	White/Yellow (94)
D7–2		9A	2	Grey (8)
D7–1		4A	1	Orange (3)
D8–8	Digit 8	25A	8	White/Black/Blue (906)
D8–4		16A	4	White/Green (95)
D8–2		10A	2	White (9)
D8–1		3A	1	Red (2)
D9–8	Digit 9 – Least Significant Digit (LSD)	26A	8	White/Black/Violet (907)
D9–4		17A	4	White/Blue (96)
D9–2		11A	2	White/Black (90)
D9–1		2A	1	Brown (1)
FUNCTION 8	Function Digit	22A	8	White/Black/Orange (903)
FUNCTION 4		19A	4	White/Grey (98)
FUNCTION 2		13A	2	White/Red (92)
FUNCTION 1		7A	1	Blue (6)
EXP 8	Exponent Digit	27A	8	White/Black/Grey (908)
EXP 4		18A	4	White/Violet (97)
EXP		1B	2	White/Brown/Orange (913)
EXP 1		1A	1	Black (Ø)
POLARITY		20A	1	White/Black/Brown (901)
EXPONENT SIGN		5B	1	White/Brown/Blue (916)
OVERLOAD		2B	1	White/Brown/Yellow (914)

The interface transfers data beginning with the most significant digit (Digit 1). If less than 9 digits of data are used, leading zeros should be programmed by connecting the most significant digits (MSD) lines to logic 0. Also, if any of the lines for function, polarity, overload, or range are not used, each must be connected to logic zero.

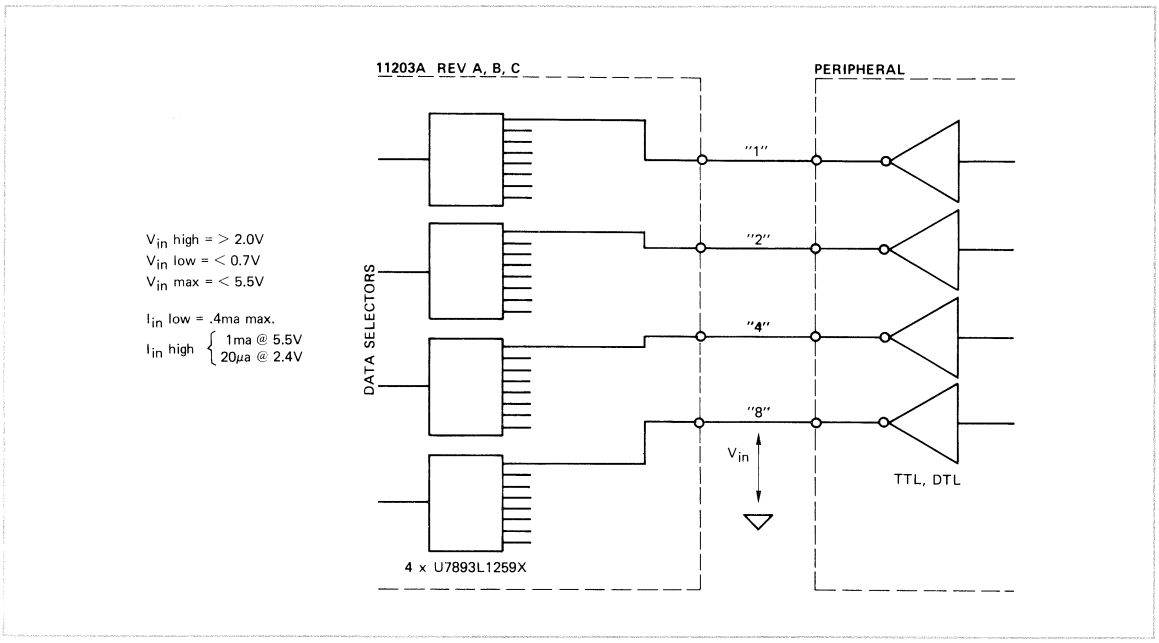


Figure 4—2. Recommended Data Lines Circuit

Data Sequence

When your device puts data onto the 11203A interface card's input lines, the card serializes the data into a 16-character sequence before transferring it to the calculator.

The sequence is:

1	Function Code
2	Comma *
3	Polarity
4	Digit 1 (MSD)
5	Digit 2
6	Digit 3
7	Digit 4
8	Digit 5
9	Digit 6
10	Digit 7
11	Digit 8
12	Digit 9 (LSD)
13	Exponent Sign
14	Overload
15	Exponent Digit
16	Delimeter *

*These characters are automatically generated by the interface card.

Function Digit: The function digit is an 8421 BCD digit and can be 0 through 9. For example, if the calculator is interfaced to a multimeter, the function digit can be used to define to the calculator what the multimeter is measuring (e.g. volts = 1 and ohms = 2).

Comma: The comma is hardwired on the interface card and is used to separate the function digit from the reset of the serialized data by loading it into a different register.

Polarity (or mantissa sign): This comprises one binary bit.

0 = Positive Mantissa
1 = Negative Mantissa

Data Digits: There is a maximum of nine data digits formed of 8421 BCD. The binary interface card enters binary codes 0 through 9 as decimal numbers. The calculator reads digit 1 first, thus this digit appears in the left of the calculator's display and therefore should be connected to your device's most significant digit.

If a decimal point is to appear in the input number, it must be programmed on the interface card. This is achieved by prewiring one of the sets of digit wires on the interface card to BCD 14 or BCD 15.

> **NOTE:** BCD 14 and 15 are recognised only by the 9810 and 9830. The 9820 and 9821 interpret BCD 14 and 15 as illegal codes and will immediately stop the operation and set an error condition in the calculator if either code occurs during an input sequence.

For example, if your device inputs to the calculator six digits and the last two of these digits represent a decimal value, it would be necessary to connect the wires representing digit 7 (pins 24A, 15A, 9A and 4A)to logic 1 (i.e. digit 7 now represents BCD 15). The Logic 1 is provided on the interface card at pins 7B, 12B, 17B and 22B.

An alternative method of causing the interface card to generate a decimal point is by prewiring the exponent digit lines (27A, 18A, 1B, 1A) to the exponent value desired and wiring the exponent sign (5B) to logic 1. If you want the number to be raised by a power connect the exponent sign to ground. If we take the previous example, where the calculator was entering six digits and the last two of the digits represent a decimal value, the exponent digit would be wired for exponent 2 (27A, 18A and 1A connected to ground and 1B connected to logic 1, i.e. BCD 2) and the exponent sign (5B) to logic 1.

If any of BCD codes 10 through 13 are set on the interface card, they will terminate the input operation (see Appendix 4).

Exponent Sign: One binary bit. 0 gives a positive exponent, 1 gives a negative exponent.

Overload: One-binary bit. This will be logic 1 if the device goes overload. The overload condition generates a positive exponent of 80.

Exponent Digit: An 8421 BCD digit. Only 0 through 9 is legal.

Delimiter: Hardwired on the interface card. It signals the calculator end of entry and gives control back to the calculator.

Loading Data

The device must load data onto the input lines in parallel and the data must remain stable for the period shown by the following table.

Calculator	ROM	Stabilising time	Maximum sample rate/sec*
9810A	PC I PC II	25 msec. 25 msec.	40 40
9820/9821A	PC I PC II	250 msec. 50 msec.	4 20
9830A	Extended I/O	55 msec.	18

*Sample rate depends on program used to enter data.

CONTROL LINES

There are two control lines, Control 1 and Control 2. Normally only one of these lines is used.

The control line should be connected to a line in your device which will enable the calculator to control the data sample cycle: this can be a 'trigger' or a 'hold off' line. Thus, with the control line, the calculator has complete control over the sample cycle.

Mnemonic	Interface Connector Pin Number	Wire Colour (Colour Code)
CTL1 CTL2	28B 27B	White/Green/Grey (958) White/Green/Violet (957)

Both the Control 1 and Control 2 lines go low — causing your device to take a data sample — when the interface card receives a Data Request signal from the calculator. However, the interface card holds Control 1 low until it detects a falling edge of your device's Flag signal ; whereas, the interface card holds Control 2 low only until your device's Flag line goes high (refer to Figure 4—6).

Thus, Control 1 should be used if your peripheral device requires a low level on the Control line during the entire data sampling period and if your device holds the Flag line high during the entire data sampling period.

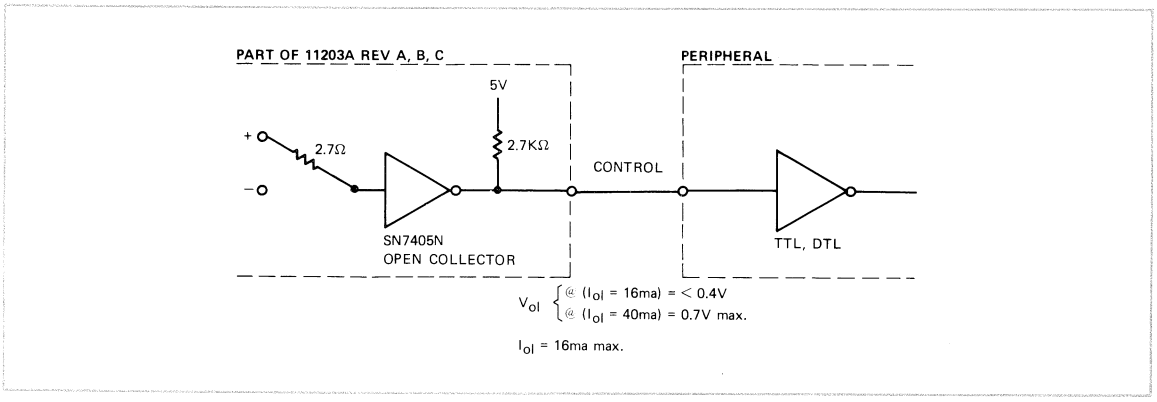


Figure 4—3. Recommended Control Line Circuit

FLAG LINE

This line must be connected to the line on your device which will indicate to the calculator that your device has accepted data from the calculator or has data to transmit to the calculator.

Mnemonic	Interface Connector Pin Number	Wire Colour (Colour Code)
FLG	29B	White/Blue/Violet (967)

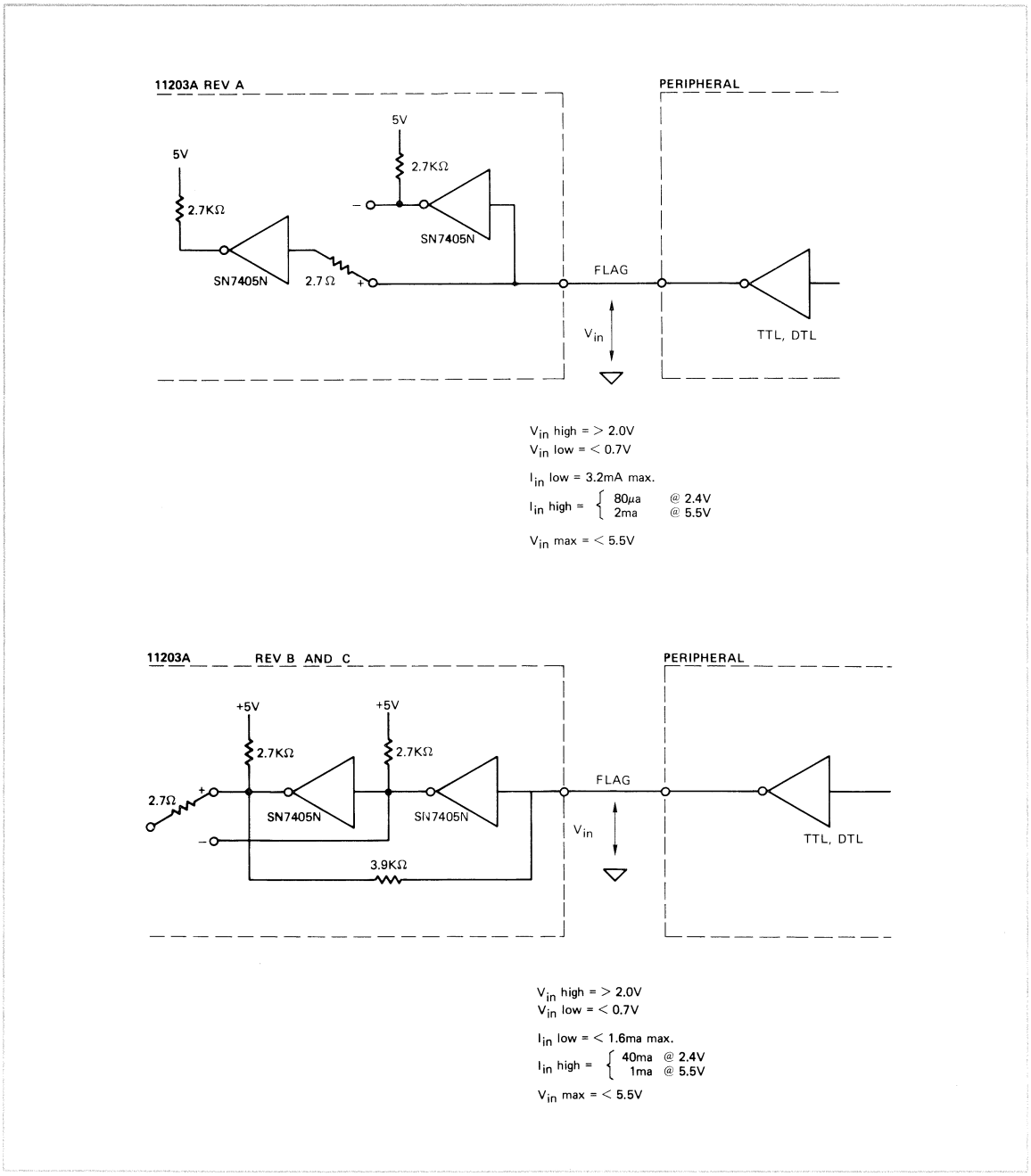


Figure 4—4. Recommended Flag Line Circuit

REFERENCE LINES

There are two of these lines. They must not be connected to your device. The purpose of the lines is to indicate to the calculator if your device uses positive- or negative-true logic (refer Appendix 1).

Mnemonic	Interface Connector Pin Number	Wire Colour (Colour Code)
+	4B	White/Brown/Green (915)
–	6B	White/Brown/Violet (917)

The lines must be connected as follows:

– If your devices has positive-true logic:
4B – left open
6B – connected to ground

– If your device has negative-true logic:
4B – connected to ground
6B – left open

NOTE: Resistors, as described in 'Setting Negative- or Positive-True Logic', must also be connected for the appropriate logic (positive- or negative-true).

GROUND LINES

These must be connected to your device's ground lines.

Mnemonic	Interface Connector Pin Number	Wire Colour (Colour Code)
	3B	–
	30A	Pink
	30B	White/Blue/Grey (968)

THEORY OF OPERATION

The BCD interface card converts positive-true* BCD-coded data to negative-true ASCII-coded data which is usable by the calculator. A simplified block diagram of the interface is shown below.

*By changing the resistors for negative-true logic the interface will convert negative-true BCD-coded data to negative-true ASCII-coded data.

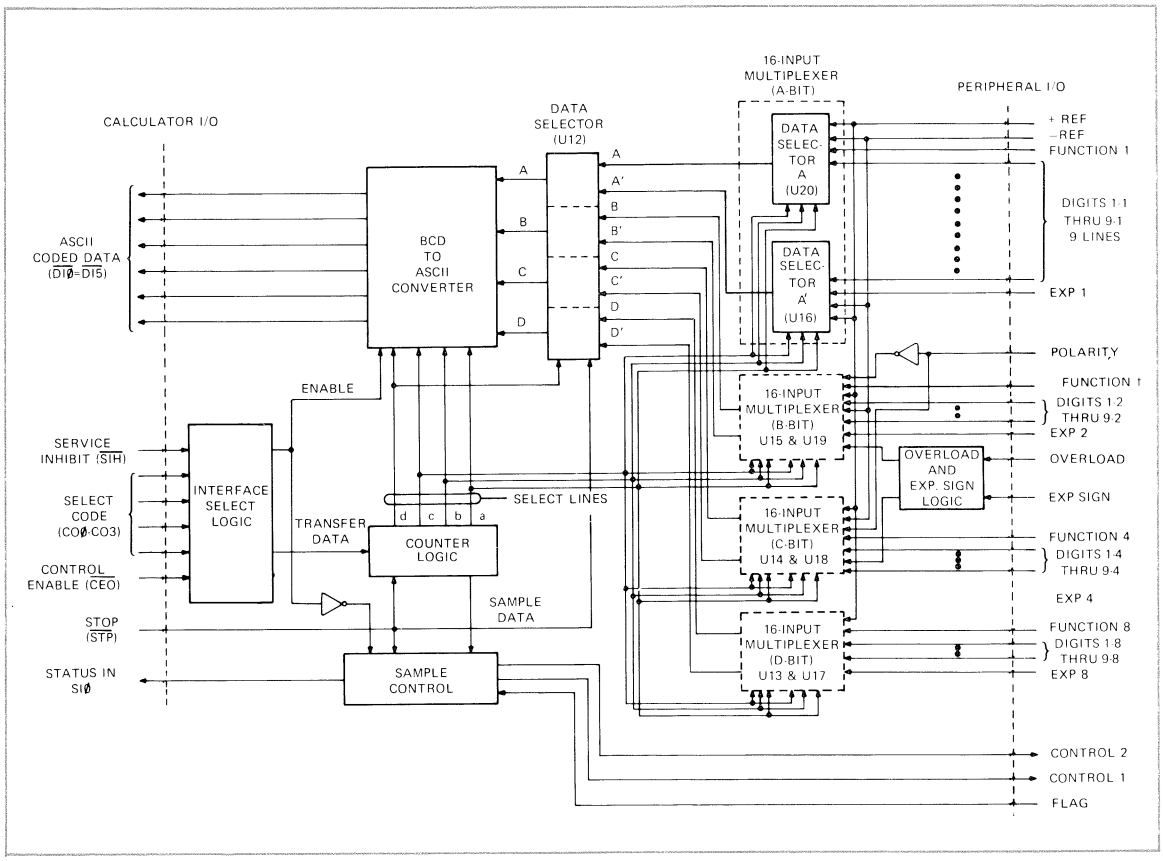


Figure 4–5. 11203A Interface Card – Block Diagram

Each data-input operation consists of a series of 16 $\overline{CEO}$ pulses from the calculator to the interface card.

Assuming the select code set on the interface card corresponds to the select code that the calculator outputs (CO0–CO3), the first negative-going $\overline{CEO}$ pulse sets the Counter Logic to 0001 and, via the Sample Control logic, sets Control 1 and Control 2 (t_0 on timing diagram).

When the Counter logic is set to 0001, it loads the function digits (Function 1, Function 2, Function 4 and Function 8) via the Data Selectors and Multiplexers into the BCD/ASCII converter, and onto the calculator input lines (DI0 through DI5). The calculator does not enter this digit until it receives the flag from your device (t_1).

The function digit is the first digit in the input sequence to be loaded into the calculator.

When the device has put data on the interface lines, it returns the flag (t_1). The interface card signals the calculator with SIØ to take the data (the first digit will be the function digit), which is on the DI0 through DI5 lines).

While the calculator is entering and processing the data, it sets $\overline{CEO}$ high (busy). The calculator signals it is now ready to enter data by forcing $\overline{CEO}$ low again (t_2).

This sequence continues until the calculator has input all the data from the device.

> **NOTE:** Regardless of the number of data bytes the device has to transmit, the calculator will always send 16 $\overline{CEO}$ pulses. Thus the speed of entering data is fixed and does not depend on the number of data elements the device transfers.

If the device outputs BCD 10, 11, 12 or 13 (termination codes) the calculator immediately stops the input operation.

ERRONEOUS TERMINATIONS

The 11203A interface card is basically a parallel-to-serial converter. A counter controls data transfers. After the sixteenth pulse the counter resets to zero. This is important because if the data transfer operation is stopped erroneously (by one of the termination codes, refer appendix 4) the counter does not reset. Instead, when the next Data Request signal comes from the calculator, to start another data transfer, the counter commences from the position in the count routine where it was stopped. The counter will, however, reset when 16 is reached.

This means that, for example, if a termination code stopped the previous operation when the count routine was at 8, the next data transfer will begin with the ninth character of the next routine. The counter routine continues until 16 is reached and then the counter is reset to zero and the data transfer stopped. Thus only the last 8 data items will have been transferred to the calculator.

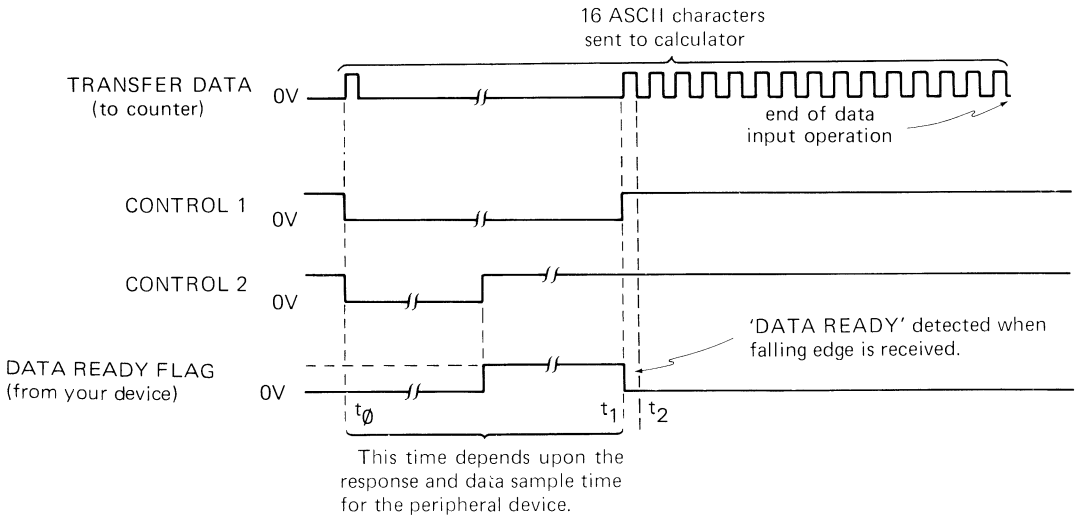


Figure 4–6. Input Timing Diagram

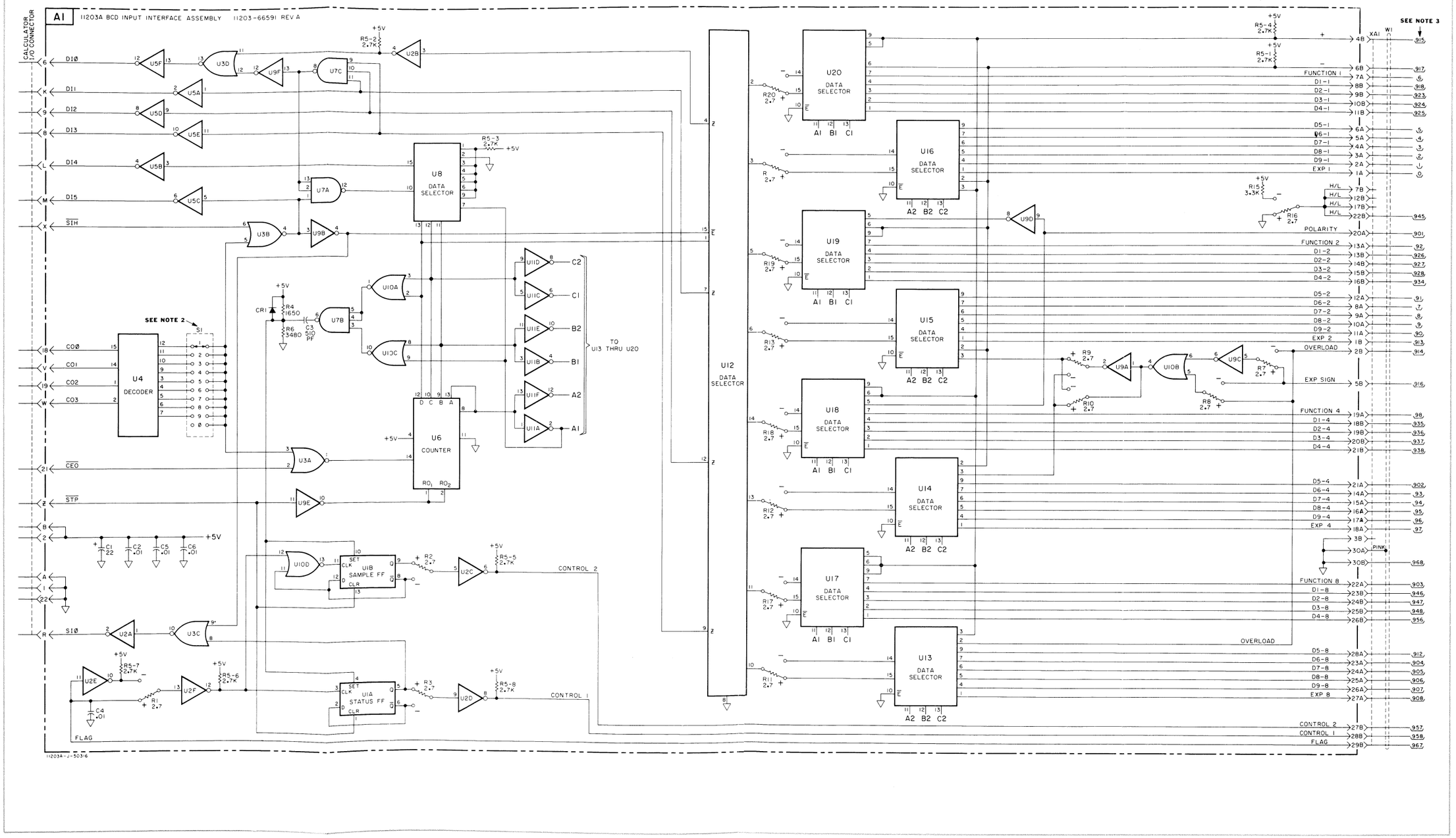


Figure 4–7. 11203A Interface Card (Rev. A Only) Circuit Diagram.

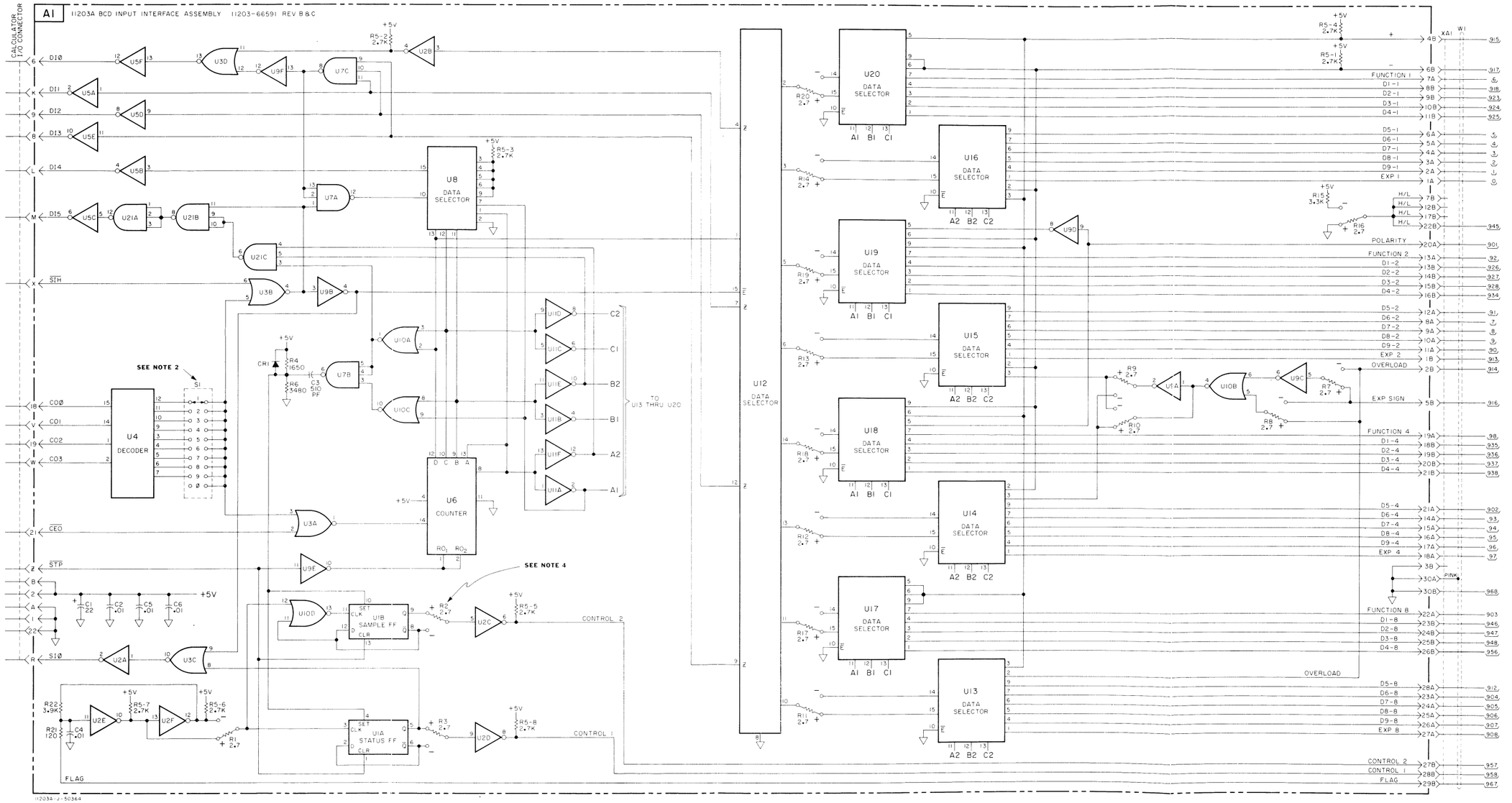


Figure 4–7. 11203A Interface Card (Rev. B and C Boards Only) Circuit Diagram.

APPENDIX 1

NEGATIVE- AND POSITIVE-TRUE LOGIC

INTRODUCTION

When describing the operation of the interface cards, reference is made to negative-true and positive-true logic. Here is a brief description of what is meant by the two terms.

On the interface, data is indicated by the appropriate line being at 0V or +5V. Depending on whether +5V is called logic 1 and 0V is called logic 0, or vice versa, determines if the logic is positive-true or negative-true. The following table shows the differences.

Definition	+5V (HIGH) > 2.4V	0V (LOW) < 0.7V
Positive-true	logic 1	logic 0
Negative-true	logic 0	logic 1

For the purpose of this description +5V and 0V have been used, however, in practice different levels for HIGH and LOW can be used.

11202A INTERFACE CARD

This interface card uses only negative-true logic. The levels are:

logic 1 (true) = < 0.7V (LOW)
logic 0 (false) = > 2.4V (HIGH)

11203A INTERFACE CARD

Negative-true or positive-true logic are selectable with this card (refer to 'Setting Negative- or Positive-True Logic). The levels are the same as for the 11202A.

APPENDIX 2

HANDSHAKING

INTRODUCTION

There are two handshake modes: handshake and corporate handshake.

The 11202A and 11203A interface cards both operate in the handshake mode. However, it is possible with the 11202A interface card — by grounding the ECH line — to select the corporate handshake mode.

HANDSHAKE MODE

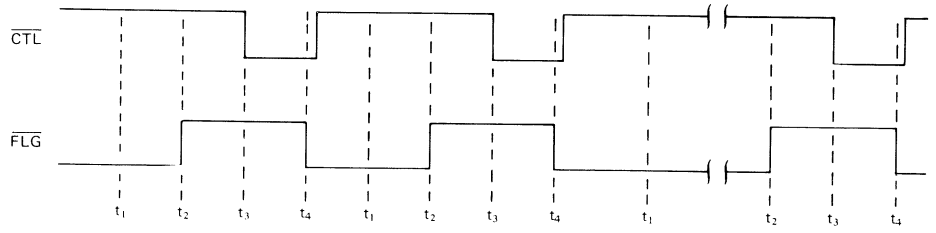
Communication (transfer of data and control signals) between the calculator and a device is by a 'handshake' type of communication. This means that the calculator sends a control signal to tell the device to send or accept data. The calculator then waits until it receives a flag from the device: indicating the device has data ready to send to the calculator or has accepted data from the calculator. The calculator will remain in the wait status until it receives the device's flag signal. In the handshake mode, the calculator can start an input or output operation at any time by sending a control signal.

CORPORATE HANDSHAKE MODE

This applies only to the 11202A.

The difference between this mode and the handshake mode is that in this mode the interface card does not set the control line and transfer data while the flag line is in the busy status: it waits until your device's flag goes 'ready'.

Another feature of the corporate handshake mode is that in this mode the calculator is able to check the status of your device, i.e. ready or busy. This feature can be used to provide a software interrupt. This may be necessary because when your device is connected to a calculator there is no provision for a hardware interrupt..



t_1 — your device holds interface 'busy' by holding FLG low.

t_2 — your device forces FLG high to continue I/O operation.

t_3 — interface forces CTL low to indicate 'ready to accept data' or 'output data is valid'.

t_4 — your device forces FLG low to indicate 'data ready' or 'data accepted'. Your device will again wait until FLG is returned high.

Figure A2—1. Handshaking

INTERRUPT

The following flowchart and programs show a method of providing a software interrupt. The 9810, 9820 and 9821 require a PCII ROM and the 9830 requires an Extended I/O ROM to do a software interrupt.

With this, the calculator 'looks at' the status of the interface. When the interface is 'busy', the calculator performs another task. When the interface is ready, the calculator branches to a data transfer routine.

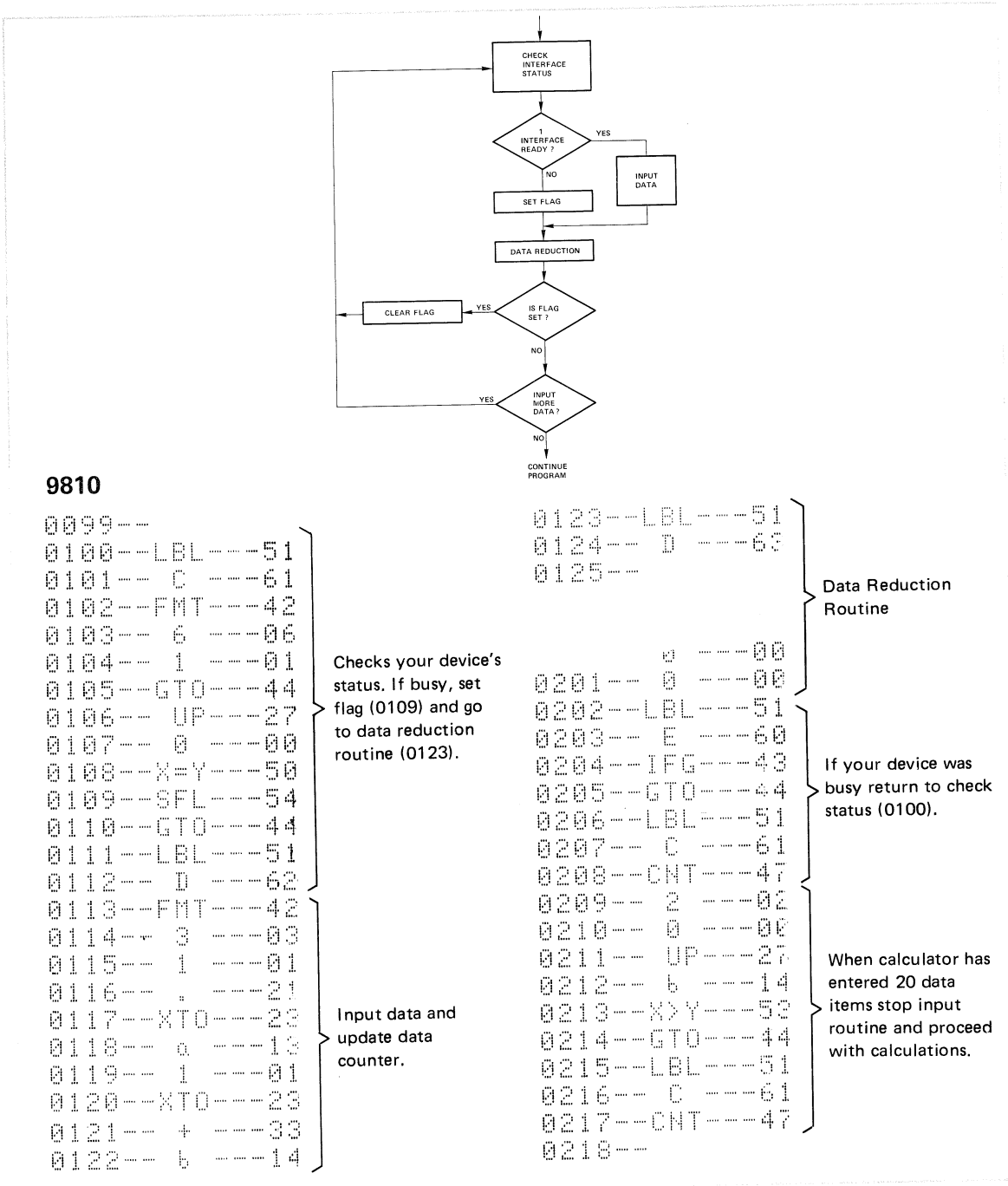


Figure A2–2. Software Interrupt

9820/9821

```
7:
IF RDS 1=0;SFG 0
;GTO 9⊢
3:
RED 1,A,B;C+1→C;
9:
```

Data Reduction
Routine

```
14:
IF FLG 0;CFG 0;
GTO 7⊢
15:
IF C≤20;GTO 7⊢
16:
```

9830

```
100 A=B=C=0
110 D=0
120 IF STAT1#0 THEN 150
130 D=1
140 GOTO 170
150 ENTER (1,*)A;B
160 C=C+1
```

Data Reduction
Routine

```
260 IF D=1 THEN 110
270 IF C<20 THEN 120
```

Figure A2–2. Software Interrupt (cont'd)

APPENDIX 3
ASCII (AMERICAN STANDARD OF CODED INFORMATION INTERCHANGE)

INTRODUCTION

ASCII is one of the most used codes in information transmission. It is an 8-channel code (the eighth bit being parity). Although the 9800-series calculators do not normally use parity, it is possible, with software, to generate a parity bit from the calculator.

Data is transferred over the interface in binary form; each line representing one binary bit.

Every ASCII character has a decimal and octal equivalent (see Appendix 9). The following paragraphs show how to convert binary to octal and decimal.

For example, in Appendix 9, the ASCII character 'A' is shown thus,

ASCII Character	Equivalent Forms		
	Binary	Octal	Decimal
@	01000000	100	64
A	01000001	101	65
B	01000010	102	66

BINARY TO DECIMAL CONVERSION

To convert the binary form to its decimal equivalent, you must first consider that each of the bits in the binary number (group of eight) represents an exponent of 2.

	Binary							
	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
ASCII 'A'	0	1	0	0	0	0	0	1

Therefore the decimal equivalent of ASCII character 'A' = $2^0 + 2^6 = 1 + 64 = 65$ (decimal).

BINARY TO OCTAL CONVERSION

Octal is based on groups of three bits. Each of the bits represents an exponent of 2. Thus to convert binary to octal, we must first divide the eight bits of the binary number into groups of three bits – starting from the right.

	Binary							
ASCII 'A'	0	1	0	0	0	0	0	1

This gives us two groups of 3-bits and 1 group of 2-bits. To each of these bits we give the following exponent values.

	Octal							
	2^1	2^0	2^2	2^1	2^0	2^2	2^1	2^0
ASCII 'A'	0	1	0	0	0	0	0	1

In each group we calculate the number by adding the exponents of 2 together and the three totals give us the Octal equivalent.

	2^1	2^0	2^2	2^1	2^0	2^2	2^1	2^0
	0	1	0	0	0	0	0	1
Octal		1			0			1

Therefore ASCII 'A' = 101 octal

APPENDIX 4

BINARY-CODED-DECIMAL (BCD)

BINARY-CODED-DECIMAL

This is a system of number representation in which a decimal digit is represented by a group of binary bits, in this case four binary bits. Each binary bit represents an exponent of two in ascending order from the left, i.e. the four binary bits represent 2^3, 2^2, 2^1, 2^0 (8, 4, 2, 1). Hence the notation '8421 BCD'. Therefore with four binary bits we have the possibility to represent 0—15. The 11203A interface cards uses only 0—9.

	BCD 2^3 (8)	2^2 (4)	2^1 (2)	2^0 (1)	Decimal	
BCD codes	0	0	0	0	0	
	0	0	0	1	1	
	0	0	1	0	2	
	0	0	1	1	3	
	0	1	0	0	4	
	0	1	0	1	5	
	0	1	1	0	6	
	0	1	1	1	7	
	1	0	0	0	8	
	1	0	0	1	9	
Illegal codes	1	0	1	0	10	see Note 1
	1	0	1	1	11	
	1	1	0	0	12	
	1	1	0	1	13	
	1	1	1	0	14	see Note 2
	1	1	1	1	15	

NOTE 1. The 11203A interface card will terminate the data sample operation if it sees any of the codes 10, 11, 12 and 13.

NOTE 2. If code 14 or 15 appear in a data string it will be interpreted as follows:

9810 and 9830 — will interpret it as a decimal point. However, if either code 14 or 15 appear a second time in the data string, the data sample operation stops.

9820/9821 — will interpret it as an error code. Data sample operation ends, program stops and an error note appears in the calculator's display.

APPENDIX 5

INTERFACING HINTS

PERMANENT OUTPUT (11202A ONLY)

By shorting the appropriate 11202A interface card output and input lines together the output character will stay permanently on the line.

Because the 9820, 9821 and 9830 calculators automatically output a carriage return and line feed as the last character in an output sequence they should be suppressed if they are not required. Otherwise the LF character will be the only character permanently on the interface lines that have been shorted.

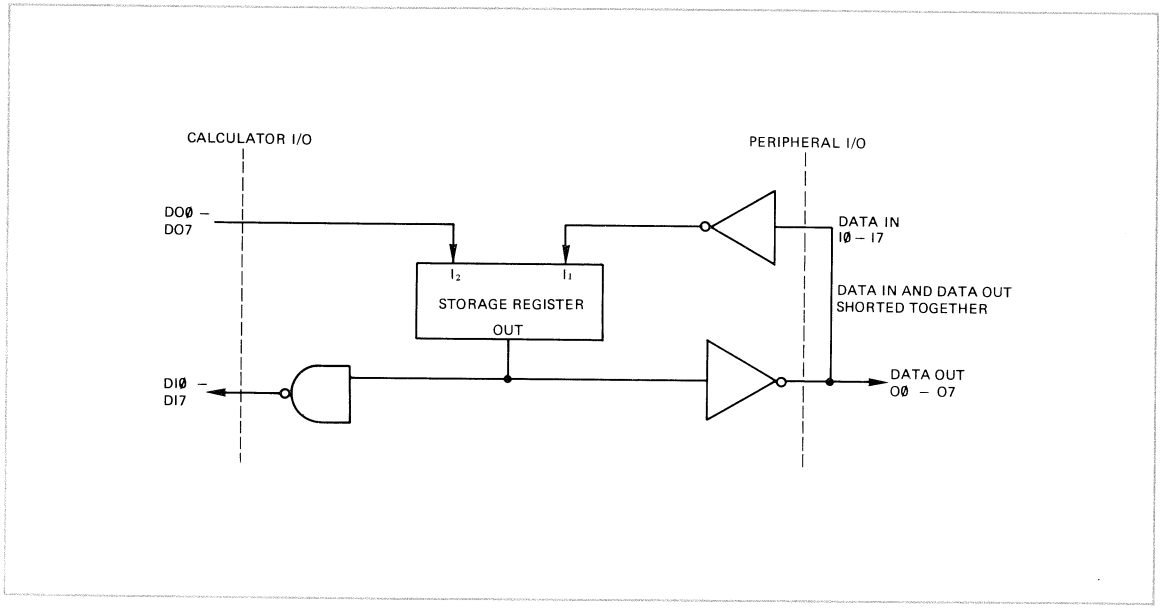


Figure A5–1. Shorting Data Input and Data Output Lines Together

16-BIT PARALLEL OUTPUT (11202A ONLY)

It is possible to output 16 bits in parallel from the calculator by using two 11202A interface cards.

Each interface card must have a different select code and the input and output lines on each card shorted together as shown in figure A5–1. In addition, the card which outputs the first eight bits should have its flag and control lines shorted together.

The flag and control on the other card must be connected to your device.

BINARY NUMBERS GREATER THAN 8-BITS (11203A ONLY)

With the 11202A interface card, binary numbers of up to eight bits can be entered into the calculator. However, when numbers greater than eight bits are to be entered into the calculator the 11203A card can be used.

With the 11203A card, binary numbers of up to 27 bits can be read into the calculator.

To do this connect all bit 8's to ground. The interface card now takes the binary number in groups of three-bits and transfers it to the calculator.

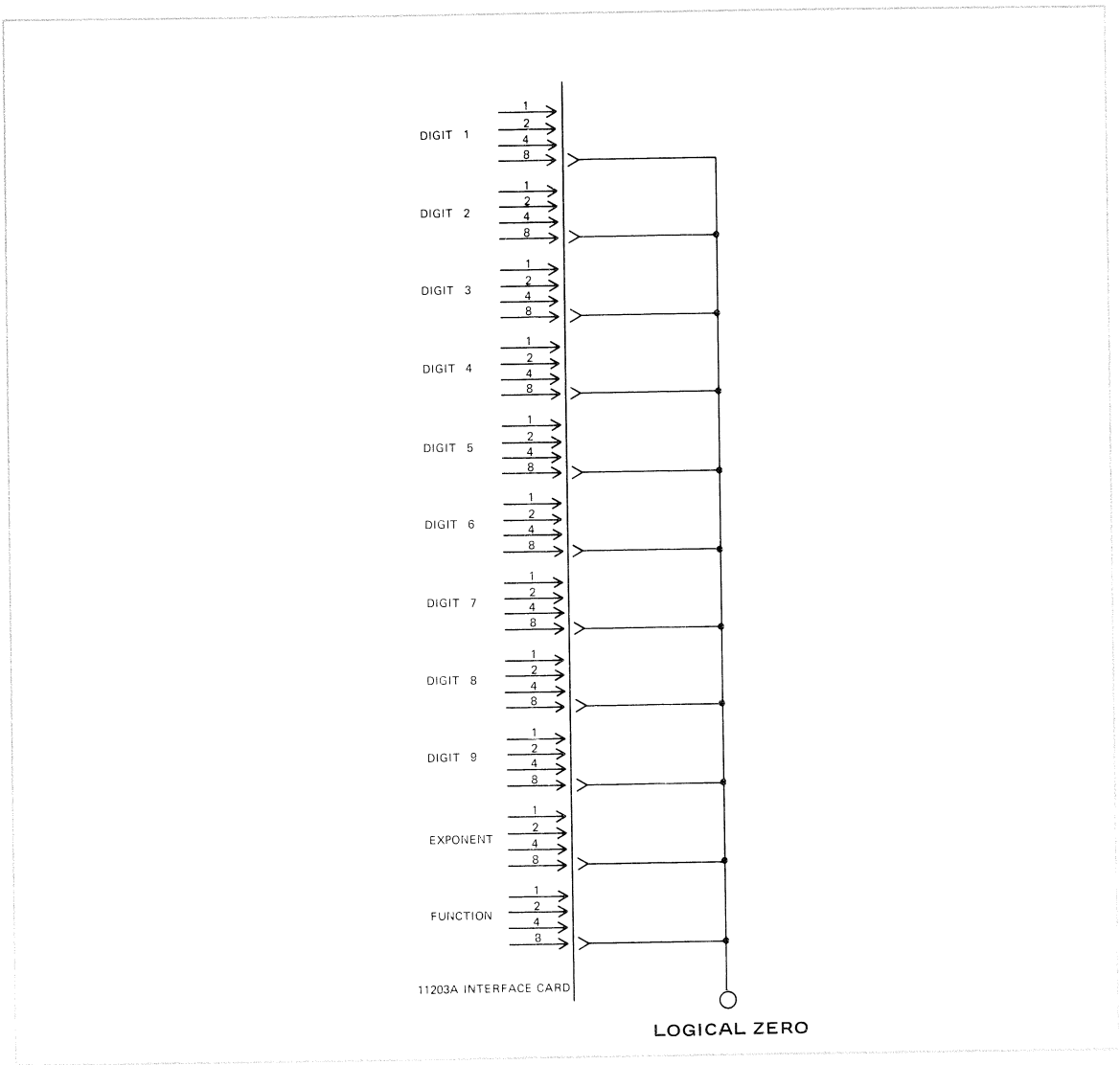


Figure A5–2. Binary Numbers Greater Than 8-Bits

Thus the number displayed in the calculator display is the octal equivalent of the binary number the device output.

With this equation, the calculator will convert the octal number to decimal from:
A = (D9 * 1) + (D8 * 8) + (D7 * 8 ↑ 2) + (D6 * 8 ↑ 3) . . . (D1 * 8 ↑ 8).

APPENDIX 6

INPUT AND OUTPUT INSTRUCTIONS

INTRODUCTION

Once you have interfaced your device to a 9800-series calculator, you will want to begin to use the system.

A comprehensive manual is provided with each calculator and ROM, however, here are some general operating instructions for the 9800-Series calculators. For more information refer to the relevant operating manual.

9810 CALCULATOR

FIELD-WIDTH

The format in which the calculator arranges and outputs data is called the 'field-width'.

When the calculator is switched on, the field-width is set to 20 characters. Numerals are right - justified in the field.

Example:

Key-in 

The number of digits after the decimal point is determined by the FIX and FLOAT keys. In this case FIX 2 would have seen selected.

The calculator arranges the digits in the field thus,

270.52

When the calculator outputs the number, it first sends 14 spaces followed by the number (14 spaces + the six digits = field width of 20).

Although the field-width is set to 20 characters when the calculator is switched on, it can be varied with the following key sequence.

Where:
W = Total field-width including sign and decimal point.
D = Number of digits behind the decimal point. The effect of D is to override the FIX and FLOAT keys.

> **NOTE:** The formula for calculating 'W' is, $W \geqslant D + 2$. The 2 is to allow for the sign and decimal point.

CARRIAGE RETURN AND LINE FEED (CR AND LF)

This calculator does not automatically output a CR AND LF. To cause the calculator to output these commands you must press:

FMT 4 select code FMT SET FLAG FMT to output a CR

FMT 4 select code FMT CLEAR FMT to output a LF

OUTPUT COMMANDS

Data Output

FMT 4 select code FMT

Outputs the number in the X-register as a string of ASCII coded numeric characters (i.e., digits, +, −, decimal point and spaces) to the peripheral specified by the select code.

Message Output

FMT 4 select code FMT

Redefines the calculator keyboard as a general output message keyboard. Pressing any of the keys shown in the following table outputs that key's equivalent ASCII code. Also, when the output message mode is set:

↑

shifts the calculator to the opposite output mode (e.g., set the shifted mode if the unshifted mode is set). The output characters available when the calculator is in the shifted output mode are coloured light-brown in the table (Appendix 9).

FMT or STOP

terminates the output message sequence and returns the calculator to the run mode.

Write Byte

FMT 6 select code x→()

This command is only possible with the PC II ROM.

A special output which converts the decimal number in the X-register to its equivalent 8-bit binary coded form and outputs the byte to the specified device. The number in the X-register can be any integer within the range of from 0 to 255. The table, Appendix 9, shows the decimal codes and their binary equivalents.

INPUT COMMANDS

Data Input

Causes the calculator to accept a series of ASCII coded characters (i.e., digits, +, —, decimal point, spaces and E). Each character but 'E' is entered into the X-register as it is received. The 'E. character causes the next two digits (and + or —, if present) to be entered as an exponent.

Read Byte

This command is only possible with the PC II ROM.
This is a special input which inputs an 8-bit byte from the specified device, converts the byte to its decimal equivalent number, and stores the number in the X-register.

9820/9821 CALCULATOR

FIELD-WIDTH

When these calculators are switched on, the field-width is set to 18 characters. Numerals are right justified in the field.

There are two methods to vary the format of the output data:

— with the FIX N and FLOAT N keys
— with a 'FORMAT' statement

The FIX N and FLOAT N keys define the format for the decimal part only of the numeral. As soon as a RUN statement is executed, the calculator reverts back to the 'floating point'.

To vary the field-width using the Format statement, press:

FMT r FXD w , d
FMT r FLT w , d

where:

r = Number of times the format is to be used
w = Total width (including sign and decimal point)
d = Number of digits behind decimal point
FXD = fixed
FLT = Scientific or floating point notation

CARRIAGE RETURN AND LINE FEED (CR AND LF)

These calculators automatically output CR and LF after each output statement.
To suppress the CR and LF instruction you must end your output statement with a 'Z'.
e.g.

FMT " $ " ; DSP 3 ; WRT 3 ;

The '$' sign will be output on the interface with the select code 3 and no CR and LF will be given.

OUTPUT COMMANDS

Write Statement

The WRITE statement is a general purpose means to output information to your device. The select code specified in the WRITE statement must correspond to the select code set in the interface card.

The WRITE statement:

WRT (select code), (parameter$_1$), (parameter$_2$), ...

or

WRT (select code), (list)

Each parameter can consist of a register name or a string of keys, which must be enclosed in quotes.

FORMAT Statement

FMT "message"&WRT (select code) &

'message' can be a string of any ASCII characters available with the calculator, see Appendix 9.

WRITE BYTE Statement

This command is only possible with a PC II ROM.

WTB (select code),(decimal number)

The (decimal number) parameter can be expressed as a positive integer, a variable (by using a register name) or an expression. The number must be a positive integer in the range from '0' to '255'. When this statement is executed, the number is converted to an 8-bit binary-coded equivalent form and sent to the specified peripheral device. A table of decimal/binary equivalent forms is shown in Appendix 9.

Example:

Execute the line:

WTB 15,65&

Result:
The 8-bit code '01000001' (ASCII character 'A') is output to the device set to select code 15.

INPUT COMMANDS

READ Statement

> **NOTE**
> READ statements cannot be executed from the keyboard; they can only be executed in a program. An attempt to execute a READ statement from the keyboard will result in a NOTE 11.

READ statement is used to input numerical data from your device. The select code must correspond to the one set in the interface card.

Incoming numbers are separated with delimiters, and the numbers themselves are permitted to assume a wide variety of forms.

READ Statement

READ (select code) , (register name 1) (register name 2)

or

READ (select code) , (list)

Delimiters

A continuous string of numeric characters, plus and minus, decimal points and E occuring between two commas, a command and a space, or two spaces, is a data item whose value corresponds to an element in a list of a READ statement. Leading spaces in a data item are ignored. Two consecutive commas indicate that no data item is supplied for the corresponding element in the list; the current value of that list element will remain unchanged and Flag 13 will be set. An initial comma causes the first element to be skipped.

A slash causes the calculator to ignore all following characters until it encounters a CR and LF. If, after the CR and LF has been encountered, there remain more elements in the list , they will be assigned values as they are read; the READ statement has not been terminated However, if a CR and LF is countered (and it does not correspond to a preceding slash) the READ statement is terminated, the values of any further list elements in the READ statement remain unchanged, and Flag 13 is set.

READ BYTE Statement

This command is only possible with the PC II ROM.

READB (select code) , (register name)

This is a special input statement. The calculator reads one 8-bit byte (e.g., one 8-line binary coded character) from the specified device, converts the information to its decimal-equivalent number and stores the number into the indicated register. If the (register name) parameter is omitted, the number is stored into the Z-register. The range of decimal numbers is from '0' through '255'.

9830 CALCULATOR

FIELD-WIDTH

When this calculator is switched on, a standard format is set (i.e. the calculator outputs the data exactly as it is keyed or programmed into the calculator, left-justified).

When the calculator outputs a number, the number, if it is a positive number, will be preceded by a space. Negative numbers will be preceded by a minus (–) sign.

There are two methods of defining the output data format:

- with the FIX N and FLOAT N keys
- with a 'FORMAT' statement

The FIX N and FLOAT N keys define the format for the decimal part only of the numeral. As soon as a RUN statement is executed ,the calculator reverts back to the 'standard format' .

Example:
Selecting FIX 2 causes the statement,

WRITE @ select code

to be output as
– 123. 46 CR and LF

The FORMAT statement defines precisely the data output format

Example:

10 FORMAT F w . d

or

10 FORMAT E w . d

where:

w = Field-width (including sign and decimal point)
d = Number of digits behind decimal point
E = Floating Point
F = Fixed Point

CARRIAGE RETURN AND LINE FEED (CR AND LF)

This calculator automatically outputs CR and LF after each output statement.

To suppress the CR and LF instruction you must end your output statement with a semi-colon (;)

e.g. 10 FORMAT F2
20 WRITE @ select code

Only the letter "A" is output.

> **NOTE:** Reference is made in line 20 to the FORMAT statement in line 10, which has a dummy format statement 'F 9.2'. Without this 'dummy' format statement, the calculator would still output a CR and LF after the last 'WRITE' or 'OUTPUT' statement in the program.

OUTPUT COMMANDS

WRITE and OUTPUT Statements

WRITE @ select code ; "message"
OUTPUT @ select code ; message

The calculator outputs the message in ASCII code. At the end of the statement the calculator outputs a CR and LF.

WRITE BYTE Statement

WRITE select code (,#) NBYTE
OUTPUT select code (,#) NBYTE

This is a special output statement which outputs the 8-bit binary equivalent of any decimal integer from 0—255, refer to Appendix 9.

INPUT COMMANDS

ENTER Statement

ENTER select code (, format (, conversion table)) variable list (, FOR parameter)

(conversion table): optional
(variable list, FOR parameter): optional

The ENTER statement is used to input data from your device. If the incoming data is not in ASCII code, conversion to ASCII code may be included in the ENTER statement through the use of an optional conversion table parameter. Also, optional FOR parameters may be used to input multiple data items from one record into an array. A record is a sequence of characters ending with a line feed (LF).

The ENTER statement causes one record to be read from the device indicated by the select code. Character-by-character conversion to ASCII code is performed, if requested, until a standard ASCII line feed character (LF) is found, signalling the end of a record. The data is then handled in the same way as during a standard READ or INPUT statement.

If a standard ASCII left arrow (←) is encountered, a backspacing operation is simulated. For example, if the input characters are 12 34, the resulting data values would be 134. If an escape (ESC) or an alternate mode (ALT) is encountered, a search is made for LF (end of record). The entire record containing ESC or ALT is ignored, and because the ENTER statement has not been terminated, the next record is accepted.

READ BYTE Statement

variable = RBYTE select code

The RBYTE Statement is a special input instruction which reads one byte of data from your device regardless of the data structure. The select code must correspond to the one set on the interface card.

The calculator stores the decimal equivalent of the data in the Variable.

APPENDIX 7

OPTIONS AND SPECIALS

INTRODUCTION

For details of options and specials contact your local HP sales office.

11202A INTERFACE CARD

11202A	General Purpose I/O Card with open-ended cable
11202A Opt.A01	11202A with connector for HP 2748B Tape Reader
11202A Opt. A02	11202A with connector for HP 2895B/H01 8100A Tape Punches
11202A Opt. A04	11202A with connector for HP 3484A multifunction unit
11202A Opt. A05	11202A with connector for HP 3485A Scanner Unit
11202A Opt. G03	11202A with connector for HP 4271A LCR Meter

11203A INTERFACE CARD

11203A	BCD Input Interface with open-ended cable
11203A Opt. A01	11203A + connector for HP 5326/27 Counters
11203A Opt. A02	11203A + connector for HP 5300A Counter
11203A Opt. A03	11203A + connector for HP 3480A/B + 3484 Multifunction Unit
11203A Opt. A04	11203A + connector for HP 3450 Digital Multimeter
11203A Opt. A05	11203A + connector for HP 3575 Gain Phase Meter
11203A Opt. A06	11203A + connector for HP 3480A/B + 3485A Scanner
11203A Opt. A13	11203A + connector for HP 4270A Capacitance Bridge
11203A Opt. G01	11203A + connector for Laser HP 5526A Interfero Meter
11203A Opt. G02	11203A + connector for K22/5321B Digital Clock
11203A Opt. G03	11203A + connector for Sartorius Balances 3002/4/5, 3012/14/15 and 3502/4

OTHER INTERFACE CARDS

11205A	Serial I/O Interface Card
11206A	Modem Interface Card
11282A	Incremental Plotter Interface + Binary tape cassette (Driver)
11285	Data Communications Interface + ROM
11286A	LX 180 Logabax Interface card*
11287A	HP 2607A Line Printer Interface Opt. 10, 20, 21 and 30

*Logabax, LX 180: UK, Germany, Italy, Spain and France only.
** Only 9830

APPENDIX 8

STANDARD SELECT CODES

These select codes are the ones set by the factory.

Model #	Description	Select Codes 9810A	9820A/9821A	9830A
2570A	Coupler/Controller	4	4	4
9860A	Card Reader	12	12	12
9861A	Typewriter Interface	15	15	15
9862A	Plotter	14	14	14
9863A	Tape Reader	15	7	7
9864A	Digitizer	9	9	9
9865A	Cassette Memory	5	5	5
9866A	Thermal Printer	8	8	15
9867A/B	Disc Memory	—	—	11
9869A	Hopper Card Reader	1	1	1
9870A	Card Reader	12	12	12
11202A	TTL Interface	1	1	1
11203A	BCD Input	3	3	3
11206A	Modem Interface	—	—	4
11282A	Incremental Plotter Interface	—	—	14
11284A	Data Communications Interface	—	—	1
59405A	HP Interface Bus	—	13	13
09830–67960	Internal Cassette Memory for 9821A and 9830A	—	10	10

Exceptions to the Guidelines;

9861A — Select Code 15 is hardwired on 11201A's with Serial Numbers less than 1142A–00321.

9866A — Select Code 15 is hardwired in the 9830A. No interface card is necessary to connect the 9830A to the 9866A.

11282A — Select Code 14 is on position 0 of a select code switch. The 11282A can therefore have alternate select codes of one through nine.

APPENDIX 9

ASCII CHARACTERS

ASCII Character	Equivalent Forms		Decimal	Model 10 Key	Model 20/21 Key	Model 30 Key
	Binary	Octal				
♭	0100000	040	32	CONTINUE	SPACE	space bar
!	0100001	041	33	1	STOP	N/A
"	0100010	042	34	2	1 see note 3	N/A
#	0100011	043	35	3	≠	# 3
$	0100100	044	36	4	$	$ 4
%	0100101	045	37	5	%	% 5
&	0100110	046	38	6	&	& 6
' (inverted comma)	0100111	047	39	7	'	' 7
(	0101000	050	40	8	(	(8
)	0101001	051	41	9	)	) 9
*	0101010	052	42	X	*	*
+	0101011	053	43	+	+	+
, (comma)	0101100	054	44	CLEAR X	,	,
–	0101101	055	45	–	–	–
.	0101110	056	46	.	.	.
/	0101111	057	47	÷	/	/
0	0110000	060	48	0	0	0
1	0110001	061	49	1	1	1
2	0110010	062	50	2	2	2
3	0110011	063	51	3	3	3
4	0110100	064	52	4	4	4
5	0110101	065	53	5	5	5
6	0110110	066	54	6	6	6
7	0110111	067	55	7	7	7
8	0111000	070	56	8	8	8
9	0111001	071	57	9	9	9
:	0111010	072	58	X	R()	:
;	0111101	073	59	+	2 see note 3	;
<	0111100	074	60	CLEAR X	≤	<
=	0111101	075	61	–	=	=
>	0111110	076	62	.	>	>
?	0111111	077	63	÷	?	?

ASCII Character	Equivalent Forms		Decimal	Model 10 Key	Model 20/21 Key	Model 30 Key
	Binary	Octal				
@	1000000	100	64	↑ ROLL	GO TO	RESULT
A	1000001	101	65	A	A	A
B	1000010	102	66	B	B	B
C	1000011	103	67	C	C	C
D	1000100	104	68	D	D	D
E	1000101	105	69	E	E	E
F	1000110	106	70	F	F	F
G	1000111	107	71	G	G	G
H	1001000	110	72	H	H	H
I	1001001	111	73	I	I	I
J	1001010	112	74	J	J	J
K	1001011	113	75	K	K	K
L	1001100	114	76	L	L	L
M	1001101	115	77	M	M	M
N	1001110	116	78	N	N	N
O	1001111	117	79	0	O	O
P	1010000	120	80	π	P	P
Q	1010001	121	81	b	Q	Q
R	1010010	122	82	a	R	R
S	1010011	123	83	$y \to (\ )$	S	S
T	1010100	124	84	$x \to (\ )$	T	T
U	1010101	125	85	$1/x$	U	U
V	1010110	126	86	int x	V	V
W	1011111	127	87	IN DIRECT	W	W
X	1011000	130	88	$y \rightleftarrows (\ )$	X	X
Y	1011001	131	89	$x \leftarrow (\ )$	Y	Y
Z	1011010	132	90	x^2	Z	Z
[	1011011	133	91	$\sqrt{x}$	3 see note 3	N/A
\	1011100	134	92	LABEL	√	N/A
]	1011101	135	93	CHG SIGN	4 see note 3	N/A
↑	1011110	136	94	ENT ↑ EXP	ENTER EXP	↑
←	1011111	137	95	SUB RETURN	→	N/A
`	1100000	140	96	N/A	N/A	N/A
a	1100001	141	97	A	A	A
b	1100010	142	98	B	B	B
c	1100011	143	99	C	C	C
d	1100100	144	100	D	D	D
e	1100101	145	101	E	E	E
f	1100110	146	102	F	F	F
g	1100111	147	103	G	G	G
h	1101000	150	104	H	H	H
i	1101001	151	105	I	I	I
j	1101010	152	106	J	J	J
k	1101011	153	107	K	K	K
l	1101100	154	108	L	L	L
m	1101101	155	109	M	M	M
n	1101110	156	110	N	N	N
o	1101111	157	111	O	O	O
p	1110000	160	112	π	P	P

ASCII Character	Equivalent Forms		Decimal	Model Key 10	Model 20/21 Key	Model 30 Key
	Binary	Octal				
q	1110001	161	113	b	Q	Q
r	1110010	162	114	a	R	R
s	1110011	163	115	$y \to ( )$	S	S
t	1110100	164	116	$x \to ( )$	T	T
u	1110101	165	117	$1/x$	U	U
v	1110110	166	118	int x	V	V
w	1110111	167	119	IN DIRECT	W	W
x	1111000	170	120	$y \rightleftarrows ( )$	X	X
y	1111001	171	121	$x \leftarrow ( )$	Y	Y
z	1111010	172	122	x^2	Z	Z
	1111011	173	123	$\sqrt{x}$	N/A	N/A
ACK	1111100	174	124	LABEL	$\sqrt{\ }$	N/A
CTL	1111101	175	125	CHG SIGN	N/A	N/A
ESC	1111110	176	126	ENT EXP	ENT EXP	N/A
DEL	1111111	177	127	SUB RETURN	→	N/A
LF	0001010	012	10	CLEAR	*	N/A
VT	0001011	013	11	CLEAR	+	N/A
FF	0001100	014	12	SET FLAG	,	N/A
CR	0001101	015	13	SET FLAG	—	N/A
DC_1	0010001	021	17	IF FLAG	TRACE	N/A
DC_2	0010010	022	18	IF $x>y$	FIXED (N)	N/A
DC_3	0010011	023	19	IF $x=y$	FLOAT (N)	N/A
LEM	0010111	027	23	↓	7	N/A

1. Keys shown in light brown are in the 'shifted mode'. The key that selects the shifted mode is,

   for the Model 10 ↑

   for the Model 20/21 DISPLAY

   for the Model 30 SHIFT

2. Those characters that have no designated calculator key can be selected by specifying the appropriate decimal code in the WRITE BYTE statement (this only applies to those ROMs that have the WRITE BYTE facility).

3. These are blank keys located in the left-hand keyblock section of the keyboard. They are numbered from top to bottom as they appear on the keyboard. They have only any significance for the PCII ROM; for a PCI ROM they have no effect.

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HP 9820A	Calculator Peripheral Control II Operating Manual	09820–90024
HP 9830A	Calculator Extended I/O ROM Operating Manual	09830–90007

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Printed in West Germany 6/75