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CHAPTER 9: POCKET PRINTER

1. OVERVIEW

These specifications define the serial protocol used to send print and control data from Game Boy to the Pocket Printer (abbreviated to printer). Game Boy sends data to the printer in packets, and the printer responds by returning 2 bytes of status information.

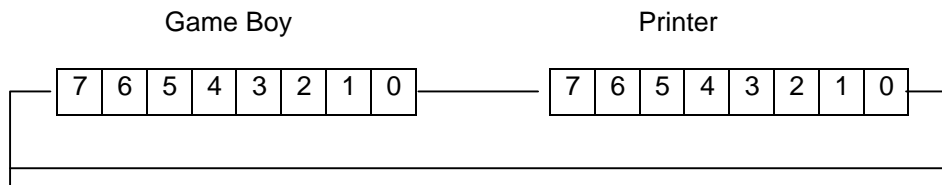
2. COMMUNICATION SPECIFICATIONS

2.1 Bidirectional Communication

Serial transfers between Game Boy and the printer are performed in the Game Boy specification communication format (bidirectional).

The shift clock is furnished by the Game Boy. Both Game Boy and the printer start transmission from the most significant bit (MSB).

For more information, see Chapter 1, Section 2.5.1, *Serial Cable Communication*.



2.2 Transfer Interval For Each Byte

An interval of 270 μ s to 5 ms must be interposed between each byte sent. Thus, care should be exercised regarding factors like interrupts when programming.

2.3 Packets and the Transfer Interval

Each type of data sent by the Game Boy is sent in a packet. An interval of 270 μ s to 117 ms must be allowed between the transfer of each packet. Thus, care should be exercised regarding factors like interrupts when programming.

2.4 Synchronism Check when Connecting

After the connection between the Game Boy and printer is confirmed, the Game Boy sends a NUL packet every 100 msec for a synchronism check of the connection. If the Game Boy determines that a connection is unnecessary and does not send a NUL packet in the prescribed time, the printer will determine that the connection is abnormal and will wait in an initialized state for a signal from the Game Boy.

3. COMMUNICATION DATA DEFINITIONS

This section defines the following data items (packet types and data) by function.

3.1 Transferring to the Printer

The packet types are as follows.

Packet Type	Code
Initialization and connection packet	01
Print instruction packet	02
Data packet	04
Data end packet	04
Break packet	08
NUL packet	0F

Each of the above packet types is in the following format.

Preamble	Header	Data	Checksum	Dummy
----------	--------	------	----------	-------

Preamble:	2 bytes of data: 0x88 x 1 + 0x33 x 1. Abbreviated PA below.
Header:	4 bytes of contiguous data that represent the following. Byte 1: Packet type 01: Initialization and connection packet 02: Print instruction packet 04: Data packet 08: Break packet 0F: NUL packet Byte 2: In the case of a data packet, indicates compression/no compression. If another type of packet, fixed at 0x00. Bytes 3 and 4: Data volume (2 bytes), number of bytes of data
Data:	Data in Game Boy character data format. Print instruction data.
Checksum:	2 bytes of data representing the sum of the header + all data in the data portion of the packet.
Dummy:	2 bytes of dummy data used to obtain status information from the printer. In the data received from the printer in place of the dummy data, byte 1 holds the peripheral device number and byte 2 holds the printer status.

3.2 Receiving from the Printer

The printer returns 2 bytes of status data.

Byte 1: Device number

1	0	0	0	0	0	0	1
---	---	---	---	---	---	---	---

The value of the MSB is always 1. The lower-order 7 bits represent the device number.
The Pocket Printer is device no. 1.

Byte 2: Status

LowBat	ER2	ER1	ER0	Untran	Full	Busy	Sum
--------	-----	-----	-----	--------	------	------	-----

LowBat: 1 = Low-battery error bit

0 = Battery OK

ER2: 1 = Other error

ER1: 1 = Paper jam (abnormal motor operation)

ER0: 1 = Packet error

Untran: 1 = Unprocessed data present

0 = No unprocessed data present

Full: 1 = Image data full

0 = Image data not full

Busy: 1 = Printer busy

0 = Printer ready

Sum: 1 = Checksum error

0 = Data OK

Status information is sent in reply to each 2 bytes of dummy data sent by the Game Boy.

* The status returned by the printer is FF FF when the printer is not connected to the Game Boy or not powered on.

3.3 Handling Errors

Either an error number listed below or the error number plus a description of the error would be sent to the display screen in response to an error flag in byte 2. (This information is also presented in the user's manual of the Pocket Printer. That information must be used together with the information given here.)

Status: Byte 2	Error No.
low Bat = 1	01
FF FF	02
ER1 = 1	03
ER2 = 1	04

* Error No. 02 is represented using both status bytes.

ER0 = 1 likely indicates program failure.

When an error is generated, always sever communication with the printer and inform the user of the type of error.

A value other than 0x81 for the first status byte means that a device other than the Pocket Printer is connected. This should be conveyed to the user as an error message.

4. PACKET DETAILS

4.1 The Initialization and Connection Packet

This packet is used to initialize the printer and check the connection. If the Game Boy sends a packet for checking the printer connection and a printer is connected, it returns a 2-byte status code and initializes for the start of print processing. This packet must always be sent when the Game Boy starts to access the printer. It allows transferred data to be invalidated (reset).

Actual Data

88	33	01	00	00	00	01	00	00	00
PA		Header				Checksum		Dummy	

This packet has no data section.

Normal status: 0x81 and 0x00 (For more information, see Section 3, *Communication Data Definitions*.)

Not connected: 0xFF and 0xFF.

4.2 Print Instruction Packet

Used for print instructions for single-sheet mode and copy mode (for specifying the number of sheets).

Example

88	33	02	00	04	00	01	13	E4	40	3D	01	00	00
PA		Header				Data				Checksum		Dummy	

Data: Byte 1 specifies the number of sheets. 0-255 (1 in the example). 0 means line feed only.

Data: Byte 2 indicates the number of line feeds. Higher-order 4 bits represents the number of feeds before printing.

Lower-order 4 bits represents the number after printing. Each value is 0x00-0x0F.

* 1 feed = 2.64 mm

Data: Byte 3 holds the palette values. Default is 00. Palettes are defined by every 2 bits beginning from high bit. (See Chapter 2, Section 2.3, *Character RAM*.)

Data: Byte 4 is the print density adjustment. 0x00-0x7F. Default values are 0x40 and 0x80 or greater.
 00 < 0x40 < 0x7F
 -25% 0% +25%

When printing continuous images from multiple screens, setting the number of line feeds to 0 after one screen's worth of data is printed (9 data packets and a data-end packet) enables printing to be continued from one image to the next without a break.

Cautions Regarding Print Instructions (**Caution Required**)

- Although applications can print 2-255 pages continuously, this may take a long time. Thus, the user should be provided with a means of halting a print job in progress. (See Section 4.5, *Break Packet*.)
- Whenever possible, the print density data should be backed up to avoid the inconvenience of adjusting the density at each startup.

- If a print instruction packet is set within 100 msec of when the motor is stopped, the position where printing resumes may be incorrect. Always send print instruction packets at least 100 msec after the motor has been stopped.
- Always set the number of line feeds before printing to 1 or greater and the number after printing to 3 or greater, except in the case of the previously mentioned continuous printing, when both values are 0. Other values for these parameters may in result in faulty operation, such as double printing on the same line or failure of the last printed line to reach the paper cutter.

4.3 Data Packet

Sends print data that are in character data format. The print data is sent in 1-byte increments for the specified number of bytes.

Example

88	33	04	00	80	02	Data0 ~ DataN-1	C1	C2	00	00
PA		Header				Data	Checksum		Dummy	

Notification of compression/no compression: Maximum number of data bytes is 0x280

(NoError through 0x3FF): (16 (bytes/color) x 20 (colors) x 2 (colors)).

Nine of these packets represent 1 printed sheet. (160 dots x 144 dots)

Byte 2 of the header is the compression/no compression notification byte.

* 1: Compression (* upper 4 bits have no effect)

* 0: No compression

Transmission of compressed data is accomplished by compressing one line at a time -- each line consisting of 20 characters horizontally and 2 characters vertically -- and sending the number of compressed bytes in order, beginning from the first line.

If the compressed lines exceed 0x280 bytes, the non-compressed data is sent as is (mixture of compressed and non-compressed packets). If the extended data do not fill an entire line when the packets are processed, the printer returns a packet error.

If an instruction to stop printing is received while print data is being sent, an initialization packet can be sent instead of the next data packet.

One Game Boy screen of data is represented by 9 data packets. However, a data-end packet can be sent even if the number of data packets sent is less than 9. In this case, the printer will print only the number of lines received. Line feeds can be performed by sending a data-end packet with no data packet and issuing a print instruction. The printer will then feed the number of lines indicated by the instruction.

Sending the following print instruction packet with a data-end packet but no data packet would specify that 5 sheets be printed, with 1 line feed before printing and 3 line feeds after printing, and that the pre-printing line feeds be ignored. The number of line feeds performed would therefore equal the product of number of sheets to be printed and the number of post-printing line feeds specified. Thus, in this example, the number of line feeds would be 15.

Example

88	33	02	00	04	00	05	13	E4	40	42	01	00	00
----	----	----	----	----	----	----	----	----	----	----	----	----	----

4.4 Data-End Packet

Actual Data

88	33	04	00	00	00	04	00	00	00
PA		Header				Checksum		Dummy	

This packet has no data section.

A data length of 0 for the data packet header represents the end of the print data. This must always be sent to end print data transmission.

4.5 Break Packet

Used to discontinue printing. The break packet is sent by means of the user's instructions and forcibly stops printing. (Printing is halted after 1 line is printed.)

Actual Data

88	33	08	00	00	00	08	00	00	00
PA		Header				Checksum		Dummy	

This packet has no data section.

4.6 NUL Packet

A functionless packet for requesting the current status of the printer. The printer may occasionally be halted unintentionally while printing (e.g., paper jam, low battery), so a NUL packet should always first be sent to check the printer's status.

Actual Data

88	33	0F	00	00	00	0F	00	00	00
PA		Header				Checksum		Dummy	

This packet has no data section.

4.7 Packet Error

Except in the case of a checksum error, if a packet of one of these types is sent but does not match the specification described, the printer will return a packet error.

4.8 Other Packets

Packets other than the types mentioned above are ignored by the printer.

5. PRINTER STATUS AND PACKETS

The following table shows the packets that can and cannot be sent from the Game Boy to the printer while the printer is in various states.

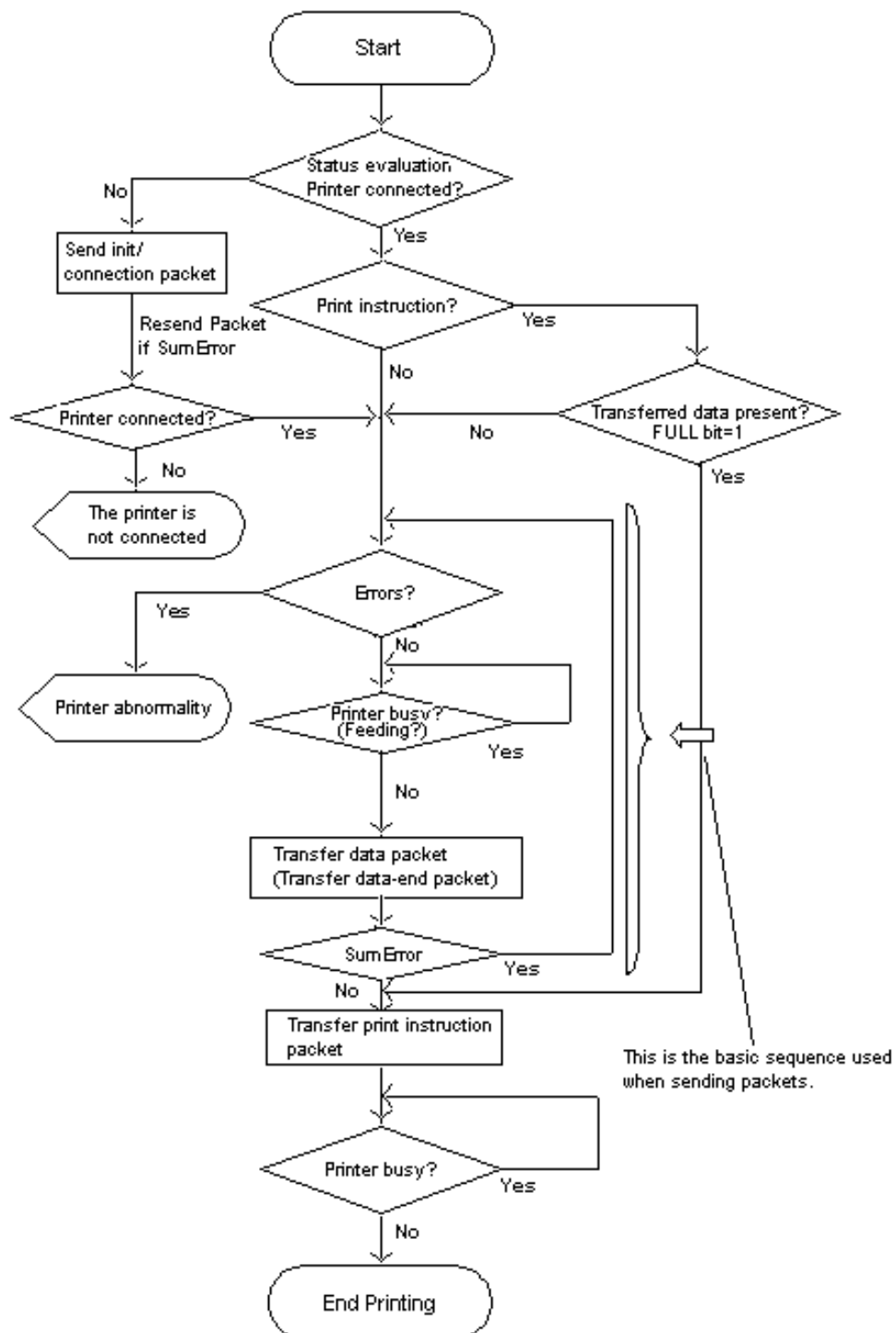
	Disconnected	Immediately after Connected	Print Buffer Full	While Printing	While Feeding
Connection/initialization packet	O	O	O	▲	▲
Print instruction packet	?	x	O	▲	▲
Data packet	?	O	x	▲	▲
Data-end packet	?	O	x	▲	▲
Break packet	?	▲	▲	O	▲
NUL packet	?	O	O	O	O

O = OK; ▲ = ignored; x = packet error; ? = undefined

* The user could push the feed button while data is being transferred. In this case, the entire data packet would be ignored, so the same packet would need to be re-sent.

6. PRINTER PRINT SEQUENCE

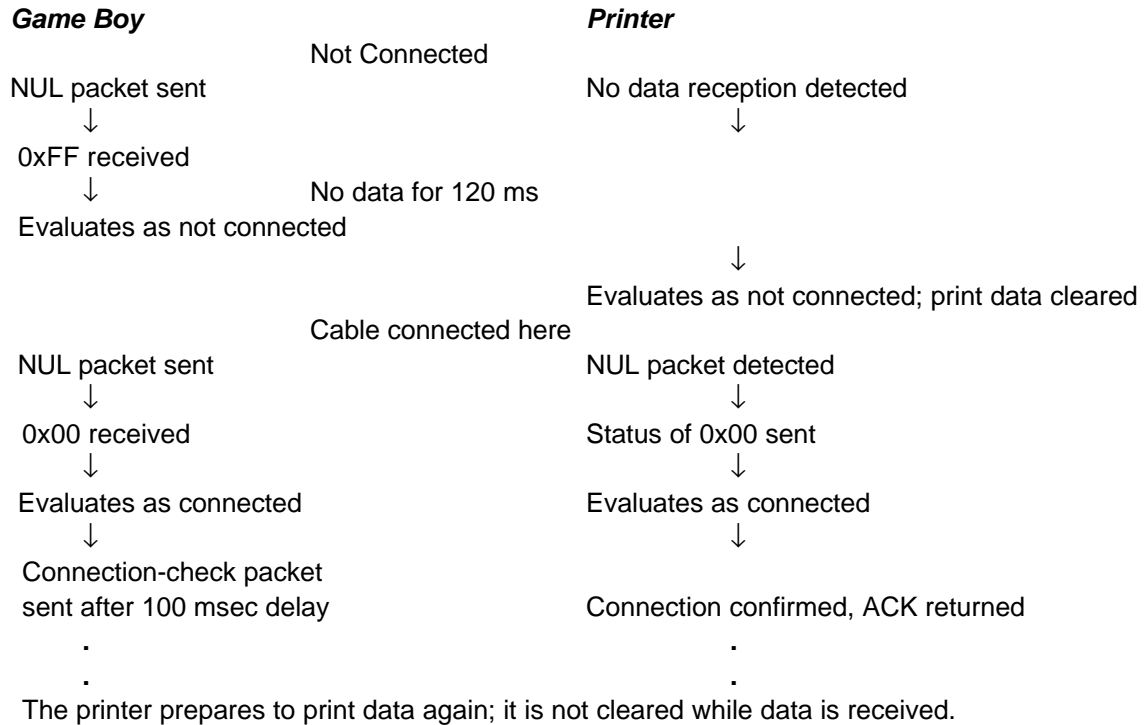
The print sequence used in the Game Boy.



7. PROCESSING OF CONNECTION EVALUATION AND PREAMBLE DETECTION FAILURE

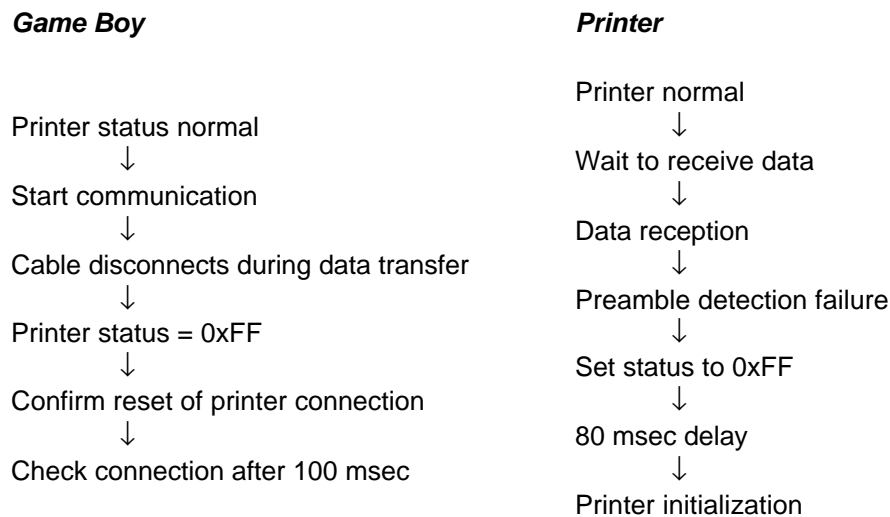
7.1 Connection Evaluation (includes cable disconnection)

To check whether a printer is connected to the Game Boy, it sends a NUL packet. If nothing is connected, the value 0xFF is received; if there is a connection, 0x00 is received.



7.2 Preamble Detection Failure

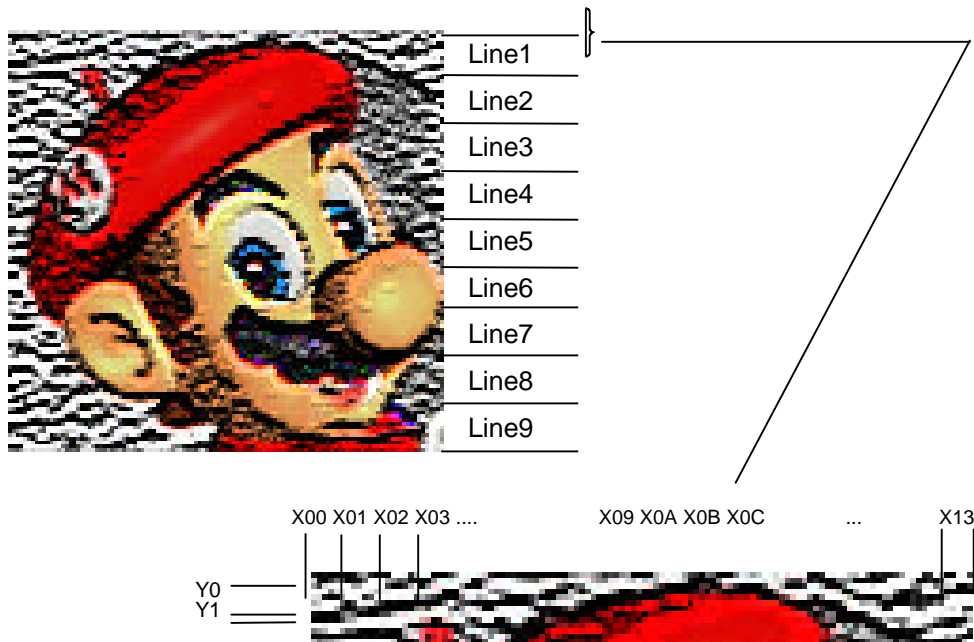
If preamble detection fails during data reception, the flow of the Game Boy and printer sequences are as shown below in parallel.



8. PRINT DATA

The print data transferred in data packets is in character data format.

Printing Example



Transfer Order

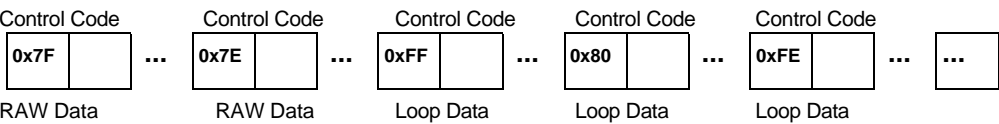
Y0.X00 --> Y0.X01 --> Y0.X02 --> ... Y0.X13: 2 x 8 x 20 = 0x140 bytes
Y1.X00 (2 x 8) --> Y1.X01 --> ... Y1.X13: 2 x 8 x 20 = 0x140 bytes
Total 0x280 bytes

1 CHAR =
2 bytes (higher grayscale, then lower grayscale) x 8 dots
vertically

9. COMPRESSION ALGORITHM

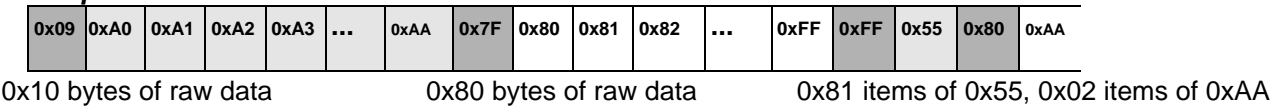
Compressed data essentially consist of control codes specifying the data type and length and the actual data.

- ① Control code 1 + raw data
- ② Control code 2 + loop data



- ① Control code 1 + Raw data
0x7F: Next 0x80 bytes are raw data
0x0-0x7E (N): Next < N + 1 data items (0x01-0x7F) are raw data
- ② Control code 2 + Loop data
0xFF: Repeat the next < 1 byte of data for 0x81 bytes
0x80-0xFE: Repeat the next < 1 byte of data for 2 (80) – 0x80 (FE) items

Example



10. HARDWARE SPECIFICATIONS

10.1 General Specifications

- Printing method: Thermal serial dot
- Print direction: Left to right (facing direction of paper feed)
- Total dot count: 16 x 160 (H x W/line)
- Dot pitch: 0.165 mm x 0.167 mm (H x W)
- Dot dimensions: 0.14 mm x 0.164 mm (H x W)
- Paper feed pitch: 2.64 mm
- Print width: Approximately 6.6 mm
- Printing speed: Approximately 1.1 lines/sec

10.2 Dimensions and Weight

- Dimensions: 72.2 mm x 139.5 mm x 56.0 mm (W x D x H)
- Weight: Approximately 190 g (not including battery)

11. MISCELLANEOUS

11.1 Cautions when Debugging

The printer comes in two types, each made a different manufacturer (Seiko Systems and Hosiden). During final game debugging, the game should be checked with at least 1 printer of each type. The manufacturer can be determined from the serial number on the back of the unit (Printers with PS serial numbers are made by Seiko; those with PH serial numbers are made by Hosiden.) Many of the Seiko printers obtained on the market are the normal Pocket Printer, while many of the printers made by Hosiden are manufactured according to the special Pocket Printer Pikachu Yellow specification. However, depending on the needs of the manufacturers, there is no guarantee that this distinction will hold true in the future. If obtaining a printer proves difficult, please contact Nintendo for a special consultation.

11.2 Sample Programs Provided by Nintendo (subroutines)

Modifying a program to suit the intended use is permitted. However, in creating the original program, values for timing and other parameters were calculated to allow normal operation. These parameters must therefore be carefully considered when modifying a program.

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