| REV: | PAGE: | REVISION DESCRIPTION | APPR: | DATE: |
|---|---|---|---|---|
| A | ALL | Released to production | GRW | 6/17/94 |
| B | 5 | Maximum component height was 10.5mm;<br>Removed through hole crystal note and dimension;<br>Released to production | GRW | 3/23/95 |
| C | 5 | 12.5mm height was 13.5mm;<br>Released to production (ECO #95-031) | GRW | 9/5/95 |
| C.1 | 6 | $T_{opr}$ was –10C (Min), +65C (Max) (ECO #98-046) | | |

| | | | |
|---|---|---|---|
| ***FUTABA* CORPORATION OF AMERICA SCHAUMBURG, IL.** | | DRAWING TITLE: PRODUCT SPECIFICATION | |
| | | PART NUMBER: NA204SD01AC | |
| DESIGNED BY: David Jaggi | ENGINEERING APPROVAL: | CUSTOMER NAME / PART NUMBER: STANDARD PRODUCT | |
| CHECKED BY: | MFG & MATERIALS APPROVAL: | DATE DRAWN: 10/29/98 | FILE NAME: 204SD01A.DOC |
| CUSTOMER APPROVAL: N/A | QA APPROVAL: | DATE PRINTED: 11/12/98 | SHEET: 1 OF 18 |

## TABLE OF CONTENTS



**Figures**

## 1.0 INTRODUCTION

The NA204SD01AC module consists of an 80 character VFD (4 rows of 20 characters), driver circuitry, bus interface (TTL compatible), dc/dc converter and character generator. Communication with the module is via an 8 bit parallel data bus with chip select, write, and busy control lines. The module is designed for two bus modes, single module bus mode where it is the only module connected to the data bus, and multiple module mode where it shares the data bus and write line with other peripherals (sections 3.7 & 7.0). This module is a pin compatible replacement for the Noritake CU20045SCPB-T23A 80 character VFD module. An attempt has been made to duplicate exactly the Noritake module, however there are a few exceptions. These exceptions are listed below, for more exact information refer to the noted sections of this specification.

* Parallel interface only - no serial communications
* Module thickness - surface of VFD to surface of PCB (3.3)
* Display Area (2.0 - VFD specification, 3.3)
* Supply current (3.6)
* Data hold time (3.7)

## 2.0 APPLICABLE DOCUMENTS

The following documents form a part of this product specification:

Futaba America Engineering Standard FAES 801, Printed Circuit Board Markings.

Futaba Vacuum Fluorescent Display Specification Number 204-SD-01GY.

## 3.0 SPECIFICATIONS

### 3.1 GENERAL SPECIFICATIONS

| Item | Value |
|---|---|
| Number of Characters | 4 Rows x 20 Characters |
| Character Configuration | 5x7 Dot Matrix w/Cursor |
| Character Height | 5.0 mm |
| Character Width | 3.2 mm |
| Character Pitch | 4.55 mm |
| Peak Wavelength of Illumination | Green (505 nm) |
| Luminance | 204 fL typ. |

### 3.2 SYSTEM BLOCK DIAGRAM

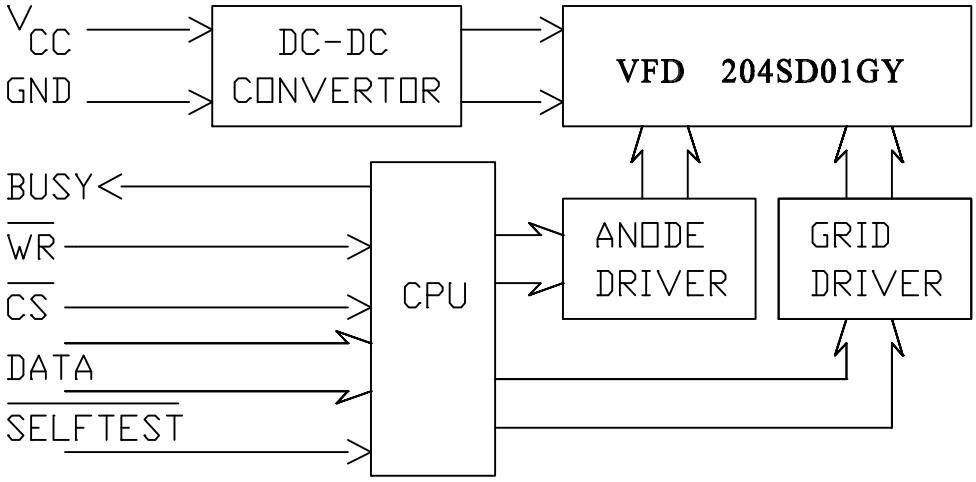


**Figure 1.** System Block Diagram

## 3.3 MECHANICAL DRAWING

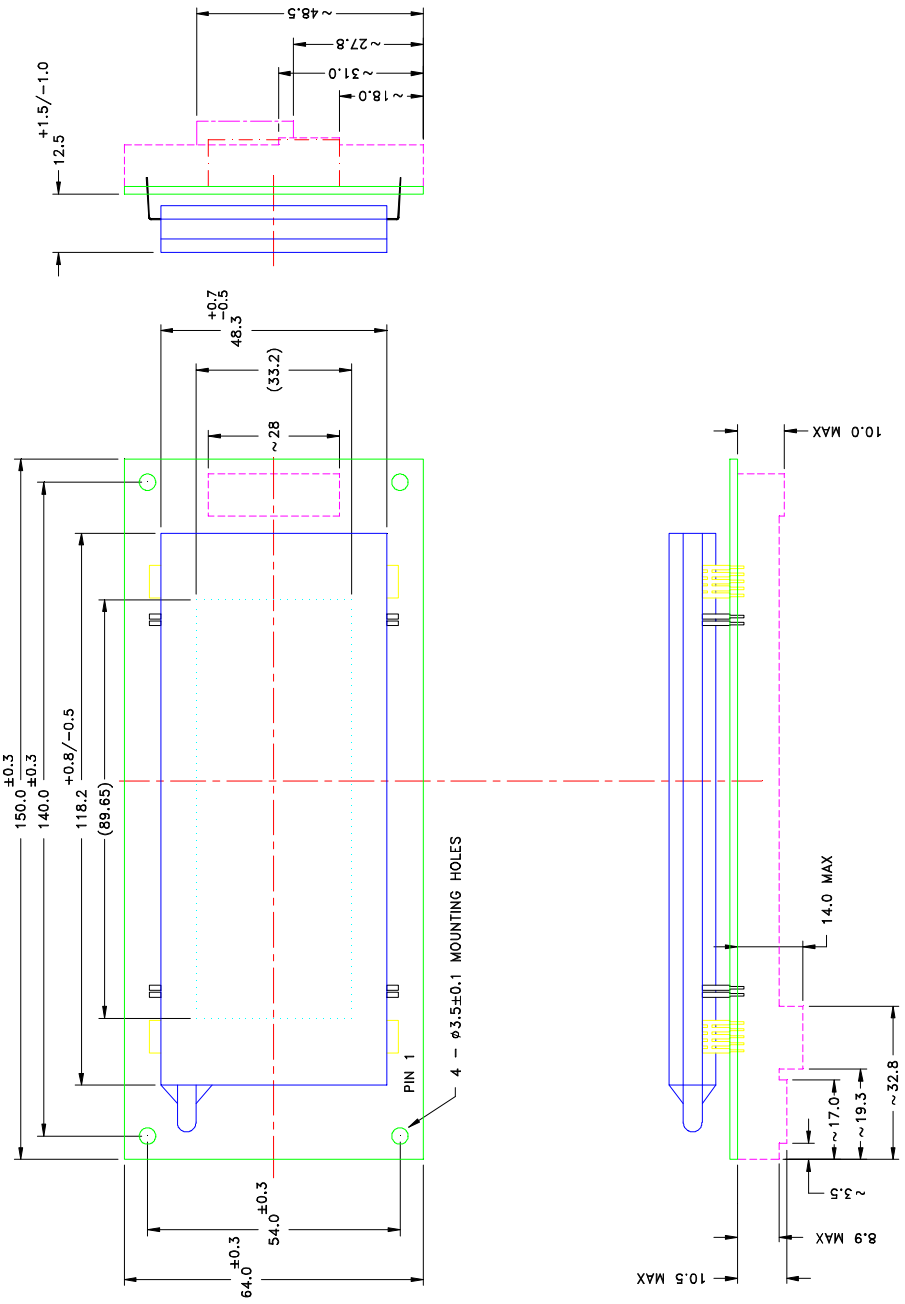


**Figure 2.** Mechanical Diagram

### 3.4 ENVIRONMENTAL SPECIFICATIONS (NOTE 1)

| Item | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Operating Temperature | $T_{opr}$ | -40 | +85 | °C |
| Storage Temperature | $T_{stg}$ | -40 | +85 | °C |
| Relative Humidity (Operating) (NOTE 4) | $H_{opr}$ | 20 | 85 | % |
| Relative Humidity (Storage) (NOTE 4) | $H_{opr}$ | 20 | 90 | % |
| Vibration (NOTE 2) | - | - | 4 | G |
| Shock (NOTE 3) | - | - | 40 | G |

Notes:

1. All environmental specification values are design goal values. Final values will be entered and this note will be omitted once environmental testing is completed.
2. Amplitude: 1.5mm; Frequency: 10 - 55 Hz; Sweep time: 1 min/cycle; Time: 2 hours/axis (x,y,z).
3. Duration: 11ms; half sine wave; 3 times each (x,y,z).
4. Without condensation.

### 3.5 ABSOLUTE MAXIMUM ELECTRICAL RATINGS

| Item | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Power Supply Voltage | $V_{CC}$ | 0.0 | 7.0 | V |
| Output Signal Voltage | $V_{out}$ | 0.0 | $V_{CC}$ | V |
| Input Signal Voltage | $V_{in}$ | 0.0 | 5.5 | V |

### 3.6 RECOMMENDED OPERATING CONDITIONS

($V_{CC}$ = 5.0V ± 5%, $T_{opr}$ = 25 °C)

| Item | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Power Supply Voltage | $V_{CC}$ | 4.75 | 5.0 | 5.25 | V |
| Power Supply Current (NOTE 1) | $I_{CC}$ | - | 0.65 | 1.0 | A |
| High Level Input Voltage | $V_{IH}$ | 2.0 | - | - | V |
| High Level Input Current ($V_{in}$=5.0) | $I_{IH}$ | - | - | 1.0 | μA |
| Low Level Input Voltage | $V_{IL}$ | - | - | 0.8 | V |
| Low Level Input Current ($V_{IL}$=0.45V) | $I_{IL}$ | - | - | -1 | μA |
| Low Level Output Voltage ($I_{OL}$=4mA) | $V_{OL}$ | - | - | 0.33 | V |
| High Level OutputVoltage ($I_{OH}$=-4mA) | $V_{OH}$ | 3.84 | - | - | V |

Note 1: A surge current of up to 2 times maximum input current can occur upon power up. The peak surge current amplitude and duration are dependent on the host power supply characteristics.

### 3.7 AC ELECTRICAL SPECIFICATIONS

(See figure 3)

| Item | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| DATA set up time | $t_{suDATA}$ | 37 | - | ns |
| DATA hold time (NOTE) (multi. module bus) | $t_{hDATA}$ | 60 | - | ns |
| DATA hold time (NOTE) (single module bus) | $t_{hDATA}$ | 11 | - | ns |
| CS\ set up time | $t_{suCS}$ | 0 | - | ns |
| CS\ hold time | $t_{hCS}$ | 0 | - | ns |
| WR\ pulse width time | $t_{wWR}$ | 30 | - | ns |
| BUSY TO CS\ delay | $t_{wBUSY-CS}$ | 0 | - | ns |
| WR\ to BUSY delay | $t_{wWR-BUSY}$ | - | 135 | ns |

Note: Minimum $t_{hDATA}$ is determined by selection of bus mode. See section 7.0 for jumper selection of bus mode.

The BUSY pulse width ($t_{wBUSY}$) is dependent upon the data written to the module. The following table lists the BUSY time during the quick write mode. BUSY time during the flickerless mode of operation will be from 2 to 15 times that of the quick write mode.

| DATA | | $t_{wBUSY}$ (MAX) | |
|---|---|---|---|
| | | DC1 MODE | DC2 MODE |
| Character data, HT, LF | | 200µs | 1000µs |
| BS, FF, CR, CT0, CT1, DC1, DC2, DC4, DC5, DC6, DC7 | | 200µs | |
| CLR | | 900µs | |
| ESC | 1st BYTE | 200µs | |
| | 2nd BYTE except 'I' | 200µs | |
| | 2nd BYTE = 'I' | 1400µs | |
| | 3rd - 8th BYTEs | 200µs / BYTE | |

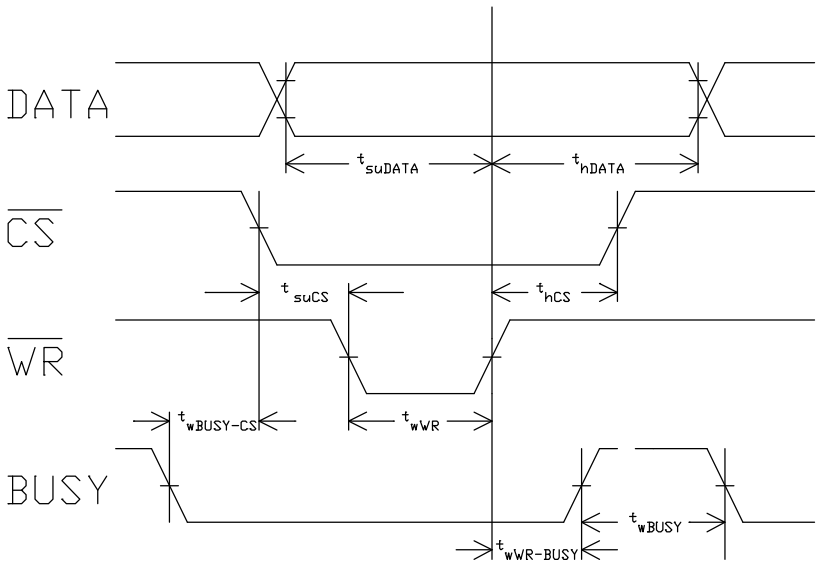


**Figure 3.** Communication Timing

## 4.0 FUNCTIONAL DESCRIPTION

### 4.1 GENERAL

Upon power up or software initialization command (section 4.4.6) the module resets to the following state:

Display cleared
Cursor set to position 1 (left most character) of row 1
Display mode set to ...
DC1 - Character over write mode
DC4 - invisible cursor
Brightness set to 100%
Blink speed set to 14H
Character table 0 selected (CT0)
Quick write mode selected.

Data is written to the module on the rising edge of the WR\ pulse while CS\ and BUSY are low. The module sets the BUSY line after data is latched, and clears the line after the data is read. The length of time that the busy line is set depends upon the data that is sent and the data write mode selected (see sections 3.7 and 4.4.4). Refer to figure 3 and section 3.7 for specific bus timing.

Since the module is in quick write mode upon power up there may be times when the display flickers during high speed data transmission. This is because in the quick write mode the communications have the highest priority resulting in a minimum busy signal. This flicker can be avoided by selecting the flickerless mode of operation (section 4.4.4).

## 4.2 CHARACTER DATA

Standard character data is from 20H to FFH (see character tables 0 and 1). User defined characters can exist at any location from 00H to FFH. Writing data from 20H to FFH or a user defined character will result in the corresponding character being displayed at the current cursor position. The horizontal tab command (section 4.3.2) is then executed.

## 4.3 COMMAND DATA

Command data is in the range of 00H to 1FH.

### 4.3.1 BS: Backspace (08H)

The cursor position is moved one position to the left. At the left most character position of rows 2 - 4 the cursor will move to the right most character position of the row above it. At the left most character position of row 1 the cursor will not move.

### 4.3.2 HT: Horizontal Tab (09H)

The cursor position is shifted to the right one position. At the right end of a row the cursor moves to the left end of the next lower row. If the cursor is at the right end of the bottom row movement depends upon DC1 or DC2 modes.

DC1 Mode:
The cursor moves to the left end of the top row.

DC2 Mode:
The contents of the each row is shifted up one row. Data in the first row is lost. The bottom row is cleared and the cursor is placed at the left most position of the bottom row.

### 4.3.3 LF: Line Feed (0AH)

The cursor is shifted to the same column position of the next lower row. At the bottom row movement depends upon DC1 or DC2 modes.

DC1 Mode:
The cursor moves to the same position of the top row.

DC2 Mode:
The contents of the each row is shifted up one row. Data in the first row is lost. The bottom row is cleared and the cursor remains at the same position.

4.3.4 FF: Form Feed (0CH)

The cursor moves to the left end of the top row.

4.3.5 CR: Carriage Return (0DH)

The cursor position is placed at the left most position of the same row.

4.3.6 CLR: Clear (0EH)

All characters are cleared. The cursor does not move.

| | | |
|---|---|---|
| 4.3.7 | DC1: Device Control 1 | (11H) (default) |
| | DC2: Device Control 2 | (12H) |

Character overwrite mode selection for character data, HT or LF commands: DC1 selects character overwrite mode. DC2 selects the scroll mode.

| | | |
|---|---|---|
| 4.3.8 | DC4: Device Control 4 | (14H) (default) |
| | DC5: Device Control 5 | (15H) |
| | DC6: Device Control 6 | (16H) |
| | DC7: Device Control 7 | (17H) |

Cursor blinking mode selection: DC4, DC6, and DC7 select an invisible cursor. DC5 selects a blinking cursor. The blink rate is controlled by the blink speed control command (sec 4.4.5).

| | | |
|---|---|---|
| 4.3.9 | CT0: Character Table 0 | (18H) (default) |
| | CT1: Character Table 1 | (19H) |

Character table selection: CT0 selects the international characters and CT1 selects the Katakana characters.

## 4.4 ESCAPE COMMANDS

The following commands are executed by first writing the escape character (1BH) followed by one or more bytes.

4.4.1 User Definable Character (1BH + 43H + CHR + B4 + B5 + B6 + B7 + B8)

Two user definable characters are available. Any 5x7 pattern of pixels can be stored at the character location identified by CHR which can be any value from 00H to FFH. Assignment of a UDC to a specific character code will cause that character or function to be replaced with the UDC. Only two UDCs that can be defined at one time. Defining additional UDCs will cause the oldest UDC to revert back to it's original character or function. If the escape command (1BH) is redefined power must be removed to restore the function. Bytes 4 through 8 (B4 ... B8) specify the specific UDC according to figure 4. Setting a bit = 1 turns on the pixel while setting the bit = 0 leaves it off (* = do not care).

UDC Example: Define a UDC at location A2H, the UDC is a dash (-). The pixels that need to be turned on are P16 - P20. The command sequence is:

1BH + 43H + A2H + 00H + 80H + 0FH + 00H + 00H

COMMAND BYTES 4 - 8

| BYTES | BIT POSITION | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 4th | P8 | P7 | P6 | P5 | P4 | P3 | P2 | P1 |
| 5th | P16 | P15 | P14 | P13 | P12 | P11 | P10 | P9 |
| 6th | P24 | P23 | P22 | P21 | P20 | P19 | P18 | P17 |
| 7th | P32 | P31 | P30 | P29 | P28 | P27 | P26 | P25 |
| 8th | * | * | * | * | * | P35 | P34 | P33 |

5x7 PIXEL MAP

| | | | | |
|---|---|---|---|---|
| P1 | P2 | P3 | P4 | P5 |
| P6 | P7 | P8 | P9 | P10 |
| P11 | P12 | P13 | P14 | P15 |
| P16 | P17 | P18 | P19 | P20 |
| P21 | P22 | P23 | P24 | P25 |
| P26 | P27 | P28 | P29 | P30 |
| P31 | P32 | P33 | P34 | P35 |

**Figure 4.** User Definable Character Map

4.4.2 Move Cursor (1BH + 48H + DATA)

The cursor position can be set to any display position by sending ESC, move cursor command (48H), and then a parameter byte identifying a specific cursor location according to the following chart:

| COL / ROW | LEFT END | 2nd | 3rd | 4th | --- | RIGHT END |
|---|---|---|---|---|---|---|
| TOP | 00 | 01 | 02 | 03 | --- | 13 |
| 2nd | 14 | 15 | 16 | 17 | --- | 27 |
| 3rd | 28 | 29 | 2A | 2B | --- | 3B |
| BOTTOM | 3C | 3D | 3E | 3F | --- | 4F |

**Figure 5.** Cursor Position Identifier Chart

DATA values of 50H to FFH are invalid and do not cause the cursor to move.

4.4.3 Luminance Control (1BH + 4CH + DATA)

Display luminance can be set to one of the following four levels by sending ESC, luminance control command (4CH), and then a luminance byte.

DATA = 00H to 3FH : 25% of maximum luminance
40H to 7FH : 50% of maximum luminance
80H to BFH : 75% of maximum luminance
C0H to FFH : 100% of maximum luminance (Default)

4.4.4 Flickerless Mode (1BH + 53H)

Flickerless mode is selected by sending 1BH + 53H. Flickerless mode makes updating the display the highest priority of the module and as such will extend the busy time for many commands. Once flickerless mode is selected the module must be powered down or sent a software initialization command (section 4.4.6) to reenter the quick write mode.

4.4.5 Blink Speed Control (1BH + 54H + DATA)

The blinking speed of the cursor (an all on character) can be controlled in 30ms increments. The period of the blinking cursor equals the multiplying value (represented by DATA) times 30ms.

| DATA | multiplying value |
|---|---|
| 00 | 256 |
| 01 | 1 |
| 02 | 2 |
| . | . |
| . | . |
| FF | 255 |

The power up default blink speed value (DATA) is 14H.

4.4.6 Initialization (1BH + 49H)

The initialization command causes the module to be reset as upon power up (sec 4.1).

## 5.0 TEST MODE

The test mode can be entered by holding the SELFTEST\ pin (pin 11) low for more than 100ms at power up or during software initialization. During the test mode all characters of character table 0 are sequentially displayed and no communication data will be accepted. The mode is exited by disconnecting power from the module.

## 6.0 CONNECTOR INTERFACE

P1 pinout(3M Connector #2516-6002UB)

| PIN | SYMBOL | PIN | SYMBOL |
|---|---|---|---|
| 1 | D7 | 2 | D6 |
| 3 | D5 | 4 | D4 |
| 5 | D3 | 6 | D2 |
| 7 | D1 | 8 | D0 |
| 9 | WR\ | 10 | CS\ |
| 11 | SELFTEST\ | 12 | BUSY |
| 13 | GND | 14 | GND |
| 15 | VCC | 16 | VCC |

## 7.0 JUMPER CONFIGURATION

The bus mode selection jumpers are located near the connector on the component side of the PCB. Solder a jumper at J1 for single module mode or at J2 to select multiple module mode. The module is initially configured for single module bus mode operation. Contact Futaba for initial setup of multiple bus mode.

## 8.0 CHARACTER TABLES

Character codes fall into the range of 20H to FFH. The following tables show the character codes for character tables 0 and 1.

| MSB: D7-D4 / LSB: D3-D0 | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0000 | | | |  |  |  |  |  |  |  | |  |  |  |  |  |
| 0001 | | DC1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0010 | | DC2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0011 | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0100 | | DC4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0101 | | DC5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0110 | | DC6 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0111 | | DC7 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1000 | BS | CT0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1001 | HT | CT1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1010 | LF | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1011 | | ESC |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1100 | FF | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1101 | CR | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1110 | CLR | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1111 | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Character Table 0

| MSB: D7-D4 / LSB: D3-D0 | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0000 | | | | 0 | @ | P | ` | p | | | | | | | | |
| 0001 | | DC1 | ! | 1 | A | Q | a | q | | | | | | | | |
| 0010 | | DC2 | " | 2 | B | R | b | r | | | | | | | | |
| 0011 | | | # | 3 | C | S | c | s | | | | | | | | |
| 0100 | | DC4 | $ | 4 | D | T | d | t | | | | | | | | |
| 0101 | | DC5 | % | 5 | E | U | e | u | | | | | | | | |
| 0110 | | DC6 | & | 6 | F | V | f | v | | | | | | | | |
| 0111 | | DC7 | ' | 7 | G | W | g | w | | | | | | | | |
| 1000 | BS | CT0 | ( | 8 | H | X | h | x | | | | | | | | |
| 1001 | HT | CT1 | ) | 9 | I | Y | i | y | | | | | | | | |
| 1010 | LF | | * | : | J | Z | j | z | | | | | | | | |
| 1011 | | ESC | + | ; | K | [ | k | { | | | | | | | | |
| 1100 | FF | | , | < | L | \ | l | \| | | | | | | | |
| 1101 | CR | | - | = | M | ] | m | } | | | | | | | | |
| 1110 | CLR | | . | > | N | ^ | n | ~ | | | | | | | | |
| 1111 | | | / | ? | O | _ | o | | | | | | | | | |

Character Table 1

| | | | |
|---|---|---|---|
| *FUTABA* CORPORATION OF AMERICA SCHAUMBURG, IL. | PART NUMBER: NA204SD01AC | REV: C.1 | |
| | DATE PRINTED: 11/12/98 | SHEET: 18 OF 18 | |