Creative Control Concepts

PIC-TV

PIC based On-Screen TV Display Interface for the Circuit Cellar® Home Control System (HCS-II) & JDS Stargate HA System

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Chapter

1

PIC-TV Overview

The PIC-TV allows Circuit Cellar® HCS-II & JDS Stargate users to display multi-color text from their systems onto any TV. Since the PIC-TV is an RS-485 serial network module, it can be located anywhere you can run a twisted pair. By using a small, self-contained video interface in SIMM format, the PIC-TV is simple to build and less likely to malfunction. This device is the BOB-II Text Overlay Board from Decade Engineering.

Users can display text on a 28x11 character grid. A powerful and flexible cursor control command set allows users to easily manipulate their displays in real-time from their HA programs. Text can be displayed on top of multi-color backgrounds or over an existing video signal. Numerous commands allow users to implement powerful and flexible TV displays. By using an IR or X10 interface, a complete 2-way interface can be implemented via any TV. Imagine using a wireless X10 remote to control your HA system via interactive menus displayed on any TV in the house.

The PIC-TV looks like a LCD-Link to the HCS-II. The PIC-TV supports most of the LCD-Link command set and adds many others necessary for color and character control. It also supports a beeper which allows users to use sound to get someone's attention when an important message appears on the TV. JDS Stargate users use ASCII-out commands to control the PIC-TV.

Adding a PIC-TV to your system will open a whole new interface media to your home automation system. Simply add it to one of your TVs or add a modulator and send it to all of your TVs. The possibilities are endless.

The PIC-TV uses a normal 9600-baud serial port so that it can be used with any system with a serial port and the ability to send commands in the proper format. Read on to find out how simple the control commands are and add the PIC-TV to your controller firmware today!

Chapter
2

Constructing your PIC-TV

If you purchased a kit from CCC, check the contents to ensure you have all the necessary parts. If you purchased your PIC-TV already assembled, skip to Chapter 8.

PIC-TV

Qty	Description	Part Reference
1	PIC-TV Circuit Board	NA
1	BOB-II Video SIMM Module	S1
1	28-Pin PIC-TV IC	U1
1	8-Pin 75176 RS-485 IC (May also be MAX483/5)	U2
1	30-pin SIMM Socket	S1
1	28-Pin IC Socket	U1
1	8-Pin IC Socket	U2
3	180Ω ¼ watt Resistors (Brown-Gray-Brown)	R1, R2, R3
1	100Ω ¼ watt Resistor (Brown-Black-Brown)	R4
1	1K ¼ watt Resistor (Brown-Black-Red)	R5
1	Red T-1¾ LED	D1
1	Yellow T-1¾ LED	D2
1	Green T-1¾ LED	D3
1	PN2222 NPN transistor (TO-92 Case)	Q1
1	Beeper	B1
1	3.6864MHz Low Profile Crystal	X1
1	Crystal Insulator (Oval Plastic w/ 2 Holes)	X1
2	20pF Capacitors (Look like green resistors)	C1, C2
1	100uF Radial Electrolytic Capacitor (Can shaped)	C3
2	0.1uF Tantalum Capacitors (tear-drop shaped)	C4, C5
2	2 Position Terminal Blocks (Blue with screws on top)	J1, J2
1	2x3 IDC Header (Gold Pins)	J3
1	2x1 IDC Header (Gold Pins)	J4
1	2x7 IDC Header (Gold Pins)	J5
1	Dual RCA Jack Connector	J6
4	Shorting Blocks	NA
2	Video Cables	NA

Here are some hints when constructing your PIC-TV:

- When building the circuit, mark off each connection on the schematic after it is soldered into place.
- Use ESD protection when handling the ICs! If you do not have a strap, touch something grounded before handling the chips.

Building your PIC-TV is quite simple. The circuit board has outlines for each part. These outlines correspond to the part numbers listed in the parts list. If you still are unsure about the placement or orientation of a part, check out the pictures of an assembled PIC-TV on our website at
http://www.cc-concepts.com/products/pictv/

1) Orient your circuit board so the side with the white diagrams faces up. All parts must be installed on this side.

2) Start with the resistors. Install R1 through R5 along with C1 & C2. Refer to the part list for resistor color codes. C1 & C2 look like green resistors.

3) Install the IC Sockets for U1 and U2. Make sure you install the socket so the notch is on the same side as the small box on the circuit silkscreen. Pin 1 of each socket should be installed in the square solder pad.

4) Install the crystal (X1), which is located next to U1. Insert the crystal through the holes in the crystal insulator and then insert the crystal into the circuit board for soldering.

5) Install the remaining capacitors C3, C4, and C5. **NOTE! These capacitors must be installed with the proper orientation.** C3 has a stripe with a minus sign in it on one side. Install C3 so the side without the strip faces the + symbol. The long lead should go into the square pad. C4 & C5 have a stripe and + symbol on them. This lead under the + symbol should be installed in the square pad so it faces the + symbol on the board.

6) Install the transistor Q1. Make sure you don't overheat the transistor when soldering it into place. Make sure you heat each lead less than 3 seconds. Use an aluminum alligator clip on the lead being soldered to dissipate heat if you need longer to solder each lead.

7) Install the IDC headers, J3, J4, and J5. When installing J4, make sure it stays straight.

8) Install the SIMM socket S1***. The SIMM socket must be installed a certain way or the BOB-II will be damaged.*** The SIMM socket has two small plastic posts on each end with tiny pegs that point horizontally. The socket must be oriented so the pegs point **AWAY** from U1. When looking down on the socket, there is a thick edge and a thin edge that surround the socket. The thick edge must be closest to U1. You'll also see that the socket groove extends all the way to the metal clips on one side, but there is a plastic insert on the other side of the socket. The SIMM socket should be oriented so the side with the plastic insert is **FARTHEST** from the video jack (J6). A final check involves the BOB-II. It is installed by placing the gold edge connector into the SIMM socket at a 45-degree angle. **DON'T SNAP IT INTO PLACE.** Simply check to see if the edge fits into the socket all the way across. If not, flip the socket around. The BOB-II and socket are keyed so the edge only fits in one way. If the orientation is correct and the BOB-II fits in the socket install S1 so the BOB-II components face U1.

   MAKE SURE THE BOB-II IS NOT INSTALLED WHEN SOLDERING S1.

9) Install the terminal blocks J1 & J2. The terminal blocks slide together using small dovetails. Attach the terminal blocks together and install them together where J1 & J2 are marked on the circuit board.

10) Install the LEDs D1-D3. Make sure the flat edge of the LED orients as indicated on the circuit board. Refer to the parts list to see which color goes where.

11) Install the beeper B1. Ensure that the + symbol on the beeper aligns with the + sign on the circuit board. **Do not remove the white seal at this time.**

12) Install the dual video jack so the jacks face away from the circuit board. Ensure the jack stays square to the circuit board when soldering. If the jack has two rectangular plastic posts on each edge, snip them off before installing it so it sits flush on the circuit board. [These are normally removed before shipment] **DO NOT CUT ANY METAL TABS!**

13) If you wish to clean the flux off your board, use a suitable flux remover. Once you have washed your board and let it dry overnight, remove the beeper seal.

14) Your PIC-TV is now complete. Testing it is simple. First, install the chips U1 and U2. Ensure the notches on the chips and IC sockets are at the same end. Make sure you don't bend any pins. Most new ICs have pins that spread slightly beyond the edge of an IC socket. Place the pins on a flat surface and bend them in slightly!

15) Install the BOB-II. Insert it at a 45-degree angle into S1. The edge should fit into the groove with no resistance. Now rotate the BOB-II towards U1. The pegs on the socket should fit into the holes on the BOB-II as it snaps into place.

16) Your PIC-TV is ready to be installed!

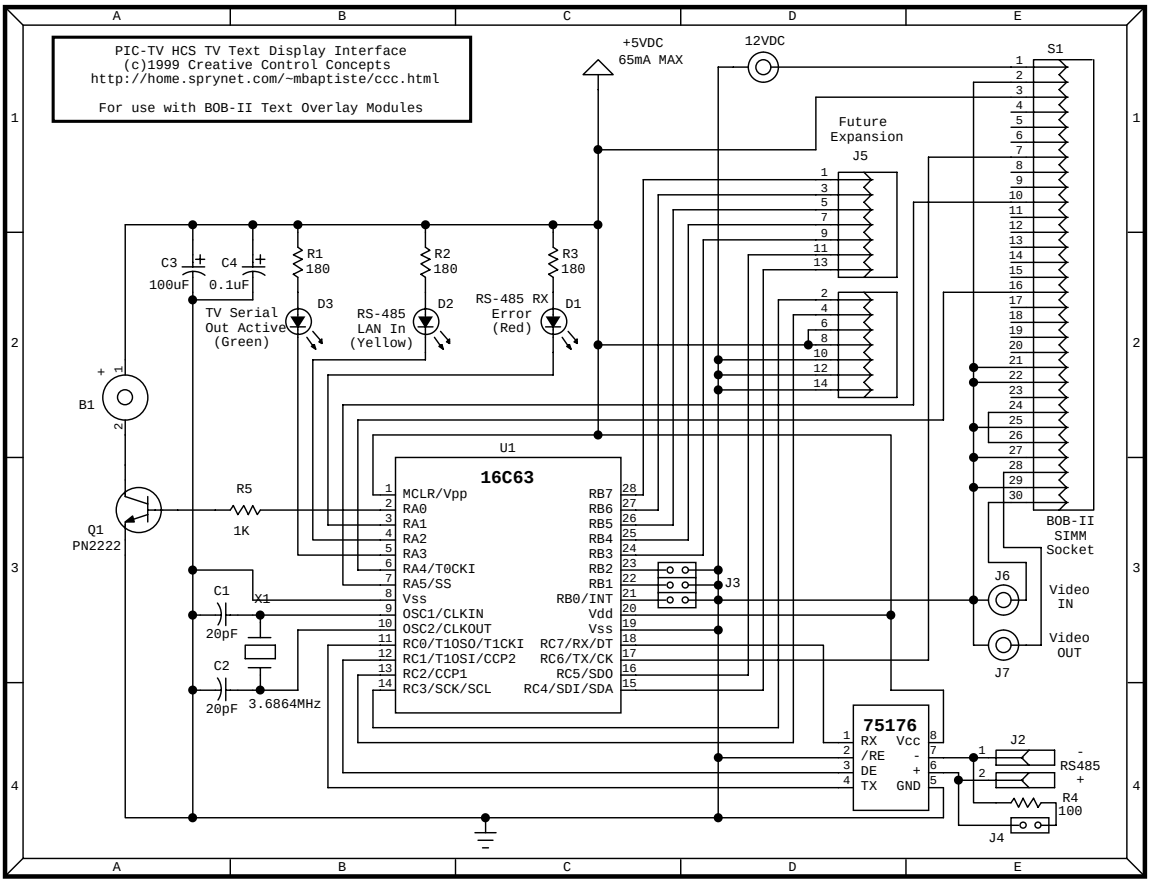


Figure 1 - Complete Schematic

Chapter

3

Installing your PIC-TV

Connecting your PIC-TV to your HCS-II is just like connecting any other HCS-II module. You'll need access to the RS-485 twisted pair network and also 12VDC. Most users carry both power and data on the same network cable. We recommend Cat 3 or Cat 5 UTP network cable. If you use a local power supply for the PIC-TV, you should run ground along with the RS-485 twisted pair to connect the grounds of your PIC-TV and your other RS-485 devices.

When connecting your RS-485 network, ensure you observe the proper polarity. Each board will be marked with a + and – sign by the RS-485 connector. If you use a system like the Stargate or ELK Magic Module, they use a different nomenclature. A is – and B is +.

The PIC-TV can be installed in a variety of ways. The simplest way is to use the video inputs on your TV or VCR. If you wish to overlay the text onto an existing video signal, connect that video signal to your PIC-TV's Video In jack (the white one). Most of today's video devices include video in & out jacks (TVs, VCRs, Satellite Receivers, etc.). Use the included video cables to make these connections.

When connecting your PIC-TV to 12VDC, **make sure the polarity is correct or you will damage your PIC-TV!**. The safest way to check this is to remove the BOB-II and both ICs. Connect power and check Pin 1 (starting from the left side) of the SIMM socket for +12V. Turn the power off and reinstall the BOB-II and ICs.

If the PIC-TV is at an extreme end of your RS-485 network, enable the network terminator by installing a shorting block on J4. Set your PIC-TV's network address as outlined in Chapter 4. You must NEVER have more than two terminators active on your network!

If you want to send the text from your PIC-TV to all the TVs in your house, use a modulator to convert the video signal to an actual unused broadcast/cable TV channel. Then combine this signal into your existing cable wiring. Tune your TV to that channel to view the HCS-II messages. Quality digital modulators can be purchased from Creative Control Concepts (http://www.cc-concepts.com/)

Taking it even further, you can combine a PIC-TV with an MCIR-Link to provide true 2-way communications with your HCS-II. Use the PIC-TV to display menus and use an IR remote via the MCIR-Link to make choices. If you have IR repeaters in each room and a modulator, you only need one PIC-TV and one MCIR-Link to access your HCS-II from any TV in your house. These advanced configurations are beyond the scope of this manual, but they are possible. JDS Stargate users can do the same using an IR Xpander.

If you want to be able to display different message sets on different TVs, purchase multiple PIC-TVs. Note that the 14-pin IDC header (J5) is for future use and is not connected during normal PIC-TV operation.

Chapter

4

PIC-TV Configuration

Before your PIC-TV can be used, it must be assigned a network address for your RS-485 network. Network addresses are assigned sequentially for specific node types. Since the PIC-TV appears as a LCD-Link to the HCS-II, take into account any existing LCD-Links you already have. For example, if you have three LCD-Links already, the PIC-TV would be assigned network address TERM3 since TERM0 through TERM2 are already used. JDS Stargate users should start with address 0 and work their way up.

To set the proper node number, use the provided shorting blocks and set the number on J3. With the PCB oriented so the text reads from left to right, the rightmost jumper is bit 0 of the network address and an installed shorting block indicates a 1. To set the address to TERM3, install shorting blocks on the two rightmost jumpers of J3 (bits 0 & 1).

The PIC-TV also has an RS-485 terminating resistor on it. If the PIC-TV will be at either end of your RS-485 network, install a shorting block on the 'Term' jumper (J4).

NOTE! Only two network devices (including the HCS-II) can have network terminators enabled at once!

To add the PIC-TV to your XPRESS program, add a LCD-Link Configuration line:

```
Config LCD-Link = #
```

Where # is the number of LCD-Links and PIC-TVs on your network. If you already have an LCD-Link configuration line, increment the number by one.

The JDS Stragate does not require you to add any type of configuration line.

Chapter

5

PIC-TV Protocol Overview

The PIC-TV recognizes most Circuit Cellar® LCD-Link character & cursor control commands used in a Circuit Cellar® HCS II Home Automation system plus some additional control commands specific to the PIC-TV. PIC-TV's are configured in XPRESS® as LCD-Links. When used on a multi-drop RS-485 network, up to eight PIC-TV's may be connected on the same network if no other LCD-Links are connected.

JDS Stargate users should read this section and the next carefully since you must build the network packets inside ASCII-out commands.

Commands are sent to the PIC-TV via a standard serial port. When connected to a Circuit Cellar® HCS II or JDS Stargate, they send and receive commands over the HCS II RS-485 multi-drop serial network. To connect a PIC-TV to a PC serial port, use a voltage shifter such as a MAX232 from Maxim. When connecting PIC-TV's to an RS-485 network, use a converter such as a 75176.

PIC-TV's communicate with their host using the following serial settings:

```
9600 Baud
  8 Bits
No Parity
1 Stop Bit
```

Command/Packet Format

When commands are sent to a PIC-TV, they must be in one of the following formats:

```
 ! TERM# command\n
#XX TERM# command\n
```

Packets starting with ! do not use checksums. If you are using checksums (see below) all packets sent to the PIC-TV must start with #. The computed checksum goes in place of the XX. Replace the # after TERM with the address number of the node which must be between 0 and 7. All packets must end with a carriage return (ASCII 13) and/or line-feed (ASCII 10).

JDS Stargate users should always use non-checksum packets for simplicity.

Replies from the PIC-TV will always start with $. If the original command packet used a checksum, the response will also have a checksum, otherwise it will not:

```
 $ TERM# reply\n
$XX TERM# reply\n
```

Checksums

To ensure reliable communications between the host computer and the PIC-TV, checksums can be used in packets to help ensure the validity of data. If the PIC-TV receives a packet with an invalid checksum, the packet is simply ignored and no response is sent. Your controller must recognize the lack of a response and resend the packet after a given timeout period. When connected to an HCS II controller, a received packet with a bad checksum is indicated by an E in the node status window.

Checksums for command packets are generated as follows:

1. Construct the command packet with zeros in the checksum location. Do **NOT** include the trailing carriage return:

   ```
   #00 TERM3 Q
   ```

2. Add up all ASCII values of all characters in the packet, except for the \n:

   ```
   #         23    (these are HEX values)
   0         30
   0         30
   space     20
   T         54
   E         45
   R         52
   M         4D
   3         33
   space     20
   Q         51
   Total     7F    (only the low byte is kept)
   ```

3. Take the 2's complement of the checksum byte computed above:

   ```
   -(7F) = 81
   ```

4. Convert the checksum byte into 2 ASCII chars and replace the zeros in the checksum location:

   ```
   #81 TERM3 Q
   ```

To validate the checksum of a received packet from a PIC-TV, do the following:

1. Discard the trailing carriage return (and linefeed if present):

   ```
   $73 TERM1 00
   ```

2. Convert the ASCII checksum into a single hex byte.

3. Replace the checksum characters with zeros in the packet:

   ```
   $00 TERM1 00
   ```

5. Add all ASCII values of the characters in the packet, minus any trailing \n or \r:

   ```
   $         24     (these are HEX values)
   0         30
   0         30
   space     20
   T         54
   E         45
   R         52
   M         4D
   1         31
   space     20
   0         30
   0         30
   Total     8D     (only the low byte is kept)
   ```

4. Add the checksum byte to the packet total. If the result is 00, the packet is probably valid:

   ```
   73 + 8D = 00    (The packet is okay)
   ```

That's all there is to it! Here is a great hint from the original Circuit Cellar® DIO-Link User Manual:

"After you think about it for a while you'll write a single subroutine to calculate or verify the checksum. If you hand the routine a line with a 00 checksum, it'll replace the zeros with the new checksum so you can send the line. If you hand it a (presumably) valid received line it will do the same, but also return the calculated checksum to the caller as an integer."

Chapter

6

PIC-TV Command Overview

The PIC-TV recognizes all the LCD-Link network commands used in a Circuit Cellar® HCS II System for displaying text on a display. It also understands the keypad query command and will respond to it, but since a keypad cannot be connected, it will always return 00. This is necessary because the HCS II uses the keypad query command to keep track of the LCD-Links and their existence on the network. If any stop responding, the HCS II will flag an error in the HOST console window.

All command packets must end with a carriage return (indicated by <CR>).

- **Query Keypad**

  This command allows the HCS II to query a LCD terminal to see if keys have been pressed. Since the PIC-TV does not support a keypad, it will return a default response so the HCS II can monitor its existence on the network. JDS Stargate users should not use this command.

```
! TERM2 Q<CR>
#cc TERM2 Q<CR>     (cc is computed checksum byte)
```

  This will return 00's for the keypad value:

```
$ TERM2 00<CR>
```

  If a checksum was included in the original packet, one will be included in the response.

- **Send Text to On Screen Display**

  To send text or control commands to the TV On Screen Display, the S= command is used. The PIC-TV has a 128-character buffer for incoming packets, though XPRESS limits you to about 80 chars of text at a time. To send text or commands to the TV, format a packet as follows:

```
! TERM3 S=\e[2JHello World<CR>
#cc TERM3 S=\e[2JHello World<CR> (cc is computed checksum byte)
```

  The above packet would clear the TV Text Display and print out "Hello World."

- **PIC-TV Control Commands**

In addition to normal text, the PIC-TV understands many ANSI and non-ANSI control commands which can be included in a S= packet (like the above `\e[2J` command). ***Note that the upper left character of any display is row,col 0,0***. The commands below handle things like cursor control, beeper control, color control, and display control.

ANSI Command Set

`\e[#A` Move cursor up # rows
`\e[#B` Move cursor down # rows
`\e[#C` Move cursor right # columns
`\e[#D` Move cursor left # columns
`\e[#;#H` 'Home' - Move cursor to row,col 0,0 (`\e[H`)
`\e[#;#f` Move cursor to row,col #,# (i.e. move to any location)
`\e[#;#j` Move cursor to row,col #,0 (\e[3j moves to row 3, column 0)
NOTE: For the above 3 commands, the #;# defaults to 0,0 if a number is not included so, technically, they all function the same way.
`\e[s` Save current cursor position
`\e[u` Jump to saved cursor position
`\e[2J` Clear display and home cursor to 0,0
`\e[K` Clear to end of row. **NOTE** the cursor will not move to end of line
`\e[7h` Set PIC-TV to wrap mode.
Lines > max # of columns will wrap onto the same line.
`\e[7l` Set PIC-TV to auto CR/LF mode
Lines > max # of columns will wrap onto the next line.

Non-ANSI Command Set

`\e[#g` Turn on Beeper for # seconds (0-10)
`\e[#M` Set Screen Color (0-7) (local video mode)
`\e[#N` Set Character Color (0-7) (local video mode)
`\e[#O` Set Character Cell Background Color (0-7) (local video mode)
`\e[#P` Set Character Outline Color (0-7) (local video mode)

- **C-Style Escape Commands**

\b	Turn Display On
\c	Turn Display Off
\e	Escape Character (ASCII 27) for above commands
\f	Clear Screen & Home Cursor to 0,0
\g	Beep for approximately 0.5 seconds
\h	Enable Character Backgrounds (local video mode)
\i	Disable Character Backgrounds (local video mode)
\j	Switch to local video mode (Color enabled)
\k	Switch to video overlay mode (This can take a few seconds)
\l	Color entire character grid with background color (local video mode)
\m	Color only char cell backgrounds (local video mode)
\n	New Line
\o	Blink On (Any Mode)
\p	Blink Off (Any Mode)
\r	Carriage Return Only
\t	Tab (4, 8, 12, 16, 20, etc.)
\x##	Output char ## in hex (See attached character code table)

Remember that the total number of characters, including the network start char, address, checksum, and command data cannot exceed 128 characters. Packets that overflow the buffer are ignored.

The BOB-II character set does NOT use ASCII codes! Refer to the attached character table to see what codes relate to given characters.

Note that letters in packet commands are case sensitive!

JDS Stargate Info

Using the PIC-TV with the JDS Stargate is very straightforward. You send raw network commands (i.e. ! TERM0 S=Hello World\n) to the PIC-TV using the ASCII-Out command. The latest version of firmware allows you to send up to 128 bytes in a single ASCII-Out command. See the command protocol section for complete information on all available network commands.

The example below will output 2 lines of text:

```
ASCII-Out:'! TERM0 S=\fInside Temp <In Temp>F\nAlarm is DISARMED and ready to Arm\n' [RS-485]
```

Chapter

7

PIC-TV Colors & Behavior

The PIC-TV chip has a 128-character buffer to store incoming commands. However, XPRESS only allows you to send approximately 80 characters in one command. This includes control sequences. JDS Stargate users should take care not to exceed the 128-character limit by joinging together too many ASCII-Out commands.

The PIC-TV is very similar to an LCD-Link as far as XPRESS is concerned. There are a few more commands available to you however. In addition, the character grid starts at 0,0 **NOT** 1,1. Thus, the X and Y limits are 27 and 10 respectively.

The BOB-II module can overlay text on top of an existing video signal (\k). However, there are some limitations when doing this. The text is always white and no backgrounds can be used. Blinking IS supported, as are all the cursor control commands. **Also, it can take a few seconds for the BOB-II to synchronize onto the external video signal so you should always send \k by itself or at the end of a packet!**

When using local video mode (\j), the video signal is generated by the BOB-II itself. You do not need an external video signal for this mode! If you draw a screen with colors in local mode and switch to video overlay, the text will all switch to white and all the backgrounds will disappear.

The BOB-II supports numerous ways of coloring the background and screen. You can change the screen color to color the entire TV screen one color (\e[#M). However, you can also specify that the selected background color paint the whole character grid (\h to enable backgrounds and \l to color grid). This will, in effect, color the screen the background color and leave the screen color as a border around the character grid. You can change the background colors behind individual characters (if the character grid paint is disabled) so that each character has a different color background (\h to enable backgrounds, \m to color cells, and \e[#O to set background color). However, they will all switch to the SAME color if you color the entire character grid. You'll also notice the background color now follows the character color since the background color is used to color the whole screen. This may sound wrong, but once you play with it you'll realize it is more flexible if not intuitive.

The best thing to do is to play around with the color modes to get a feel for how they operate. The PIC-TV does no additional processing to color commands. They are converted directly into BOB-II commands. Switching between background and cell color modes can yield some unexpected results (i.e. the screen color changes when you switch into and out of total background color mode). This is due to the onboard BOB-II processor. Its is easily compensated for by setting the proper color again.

Note that if you set the background color and select color the entire grid, it won't happen until you clear the screen (i.e. paint the screen with all spaces!). Also, if you are in the color entire

grid with background mode and disable backgrounds, you must switch to color only cell mode (\m) before it takes effect.

Note that the colors of characters are pale compared to the background colors. I have found that a small TV and cheap CH 3/4 modulator can wash out the character colors. Most VCRs and similar devices use better modulators so the colors do not wash out.

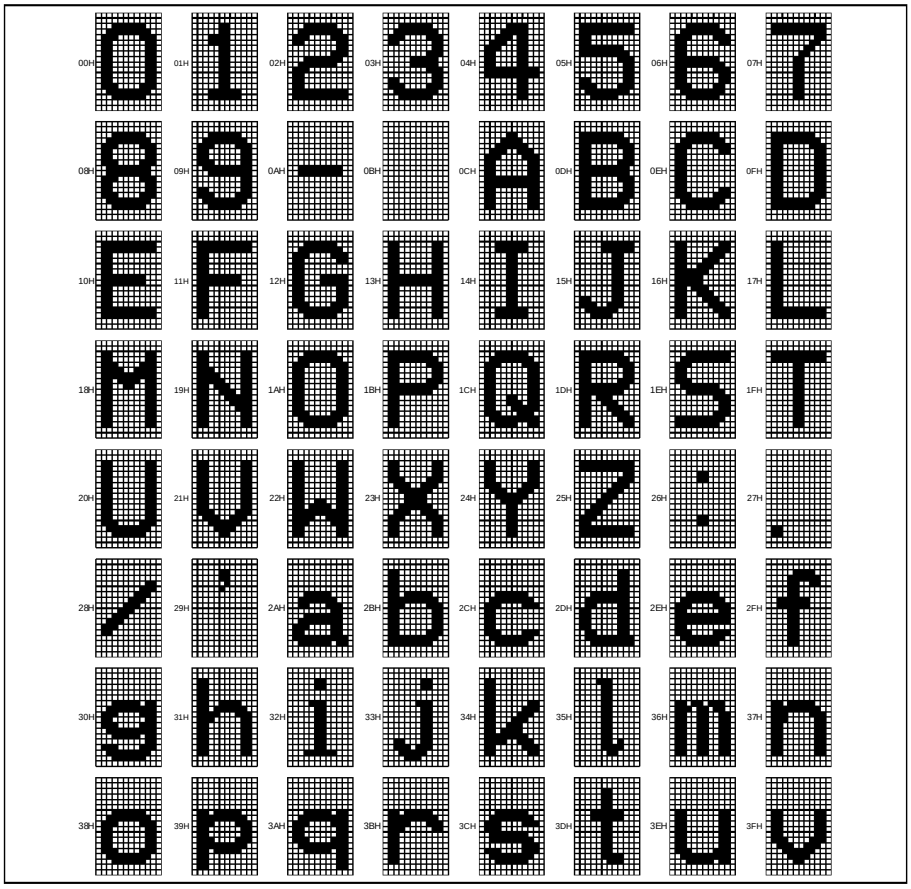
While you can color the outline of the characters too (\e[#P), some combinations of outline and character colors can destabilize the display.

Below are the color tables for characters and backgrounds.

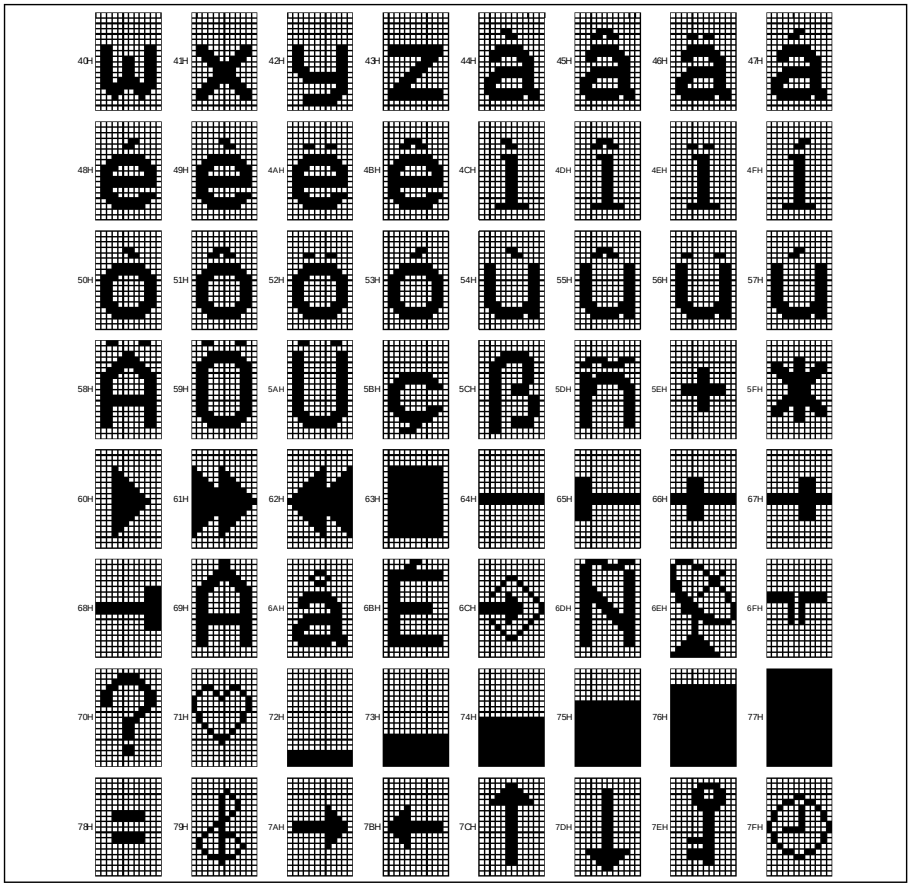
Color Code	Screen/Back Color	Character Color
0	Grey	White
1	Purple	Blue
2	Green	Green
3	Cyan	Cyan
4	Red	Orange
5	Magenta	Magenta
6	Lime Green	Yellow
7	Grey	White

Note that the BOB-II has a slightly odd character set. Some common characters are missing and it does not follow normal ASCII! Refer to the character table below. If you send normal text form the HCS-II, that text will appear on your TV. However, when you use \x##, make sure you check the character table so you know what will come out! There are many useful symbols for use in a Home Automation system like up and down arrows to show temperature trends, etc.

BOB-II Character Set, Part 1



BOB-II Character Set, Part 2



5730A-13.EPS

Chapter

8

PIC-TV Pinout

Below is the pinout for the PIC-TV chip:

PIC-TV

Pin 1	/RESET
Pin 2	Beeper Out
Pin 3	/Serial Error LED Out
Pin 4	/Lan Traffic LED Out
Pin 5	/BOB-II Serial LED Out
Pin 6	BOB-II Mode In
Pin 7	BOB-II RESET Out
Pin 8	GND
Pin 9	OSC1
Pin 10	OSC2
Pin 11	HCS-II Serial TX
Pin 12	HCS-II Serial Enable
Pin 13	Future Use
Pin 14	Future Use
Pin 15	Future Use
Pin 16	Future Use
Pin 17	BOB-II Serial TX
Pin 18	HCS-II Serial RX
Pin 19	GND
Pin 20	Vcc (+5V)
Pin 21	Node Address Bit 0
Pin 22	Node Address Bit 1
Pin 23	Node Address Bit 2
Pin 24	Future Use
Pin 25	Future Use
Pin 26	Future Use
Pin 27	Future Use
Pin 28	Future Use

NOTE: The output pins on the PIC-TV can source or sink 25mA each, up to 200mA total.

Chapter

9

Need Help?

If you get stuck trying to get your system to work, drop us a line at support@cc-concepts.com and we will do our best to help you get your PIC-TV working.

Check out our web site at http://www.cc-concepts.com/ for updates, bug reports, etc.

Here are some useful links for additional info referenced in this manual:

Microchip PICs: http://www.microchip.com

Circuit Cellar® HCS: http://www.cc-concepts.com/products/hcs/

Decade Engineering (BOB-II): http://www.decadenet.com/

JDS Stargate Info: http://www.jdstechnologies.com/