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CSYS Labs, Inc.

TVM24128

Touch Vision LCD Module

Product Information

Description:

The TVM24128 Touch Vision Module provides a complete user interface in a low cost, convenient to use module. It combines either a transflective or transmissive graphics LCD display, touch activated panel overlay, interface electronics, LCD drivers, EL back light, and power supply voltage converters. Because the TVM24128 contains on board voltage converters, only a single +5 Volt power supply is required.

The TVM24128 includes a powerful micro-processor which acts as an intelligent controller for the entire module thus making interfacing to the TVM24128 very easy. Communication with the TVM24128 is done via either a 20 wire parallel port, 8 bit instruction and data, or an RS232 serial port. Hand shaking signals are provided to control data flow and a status register is also provided to better accommodate pipe lined communication.

A rich instruction set, including both text and graphics commands, is provided. With these commands, the user can freely mix and manipulate any graphics and text being displayed. Commands can be issued to position the cursor, set up the text window size and set system attributes. Graphics commands are provided to draw rectangles, boxes, lines, vectors or to set individual pixels. Two graphics planes are provided to accommodate background and foreground operations. Four level gray scale is also an integral part of the instruction set.

Additional commands are available to activate a touch panel switch area as well as place a button outline on the LCD display automatically. The host can load the TVM24128 with the button label and then place the button via a single instruction. If enabled, the software automatically sizes the button, places the text in the center of the button, writes the button to the display, and then activates the touch panel in the button's location. When the button is pressed, the on board CPU signals the host that a button has been actuated and makes the button's code available for reading by the host. Other button commands may be used to activate a "phantom button" area, delete a button, or delete all buttons.

The TVM24128 has the ability to simultaneously mix as many as 5 fonts on the screen. Two fonts are resident in the TVM24128 controller. Up to three fonts can be custom designed and compiled using the font compiler which is part of the designer's kit. These custom fonts can be down loaded into the TVM24128's font memory and the used. Any font may be used at any time for labels anywhere, including text inside a defined button area.

Electronic contrast control eliminates the need for any hardware contrast adjustments by end users of the equipment. In addition, a course adjustment trimmer is provided on the controller board to accommodate initial factory settings. Full temperature range compensation controls variations due to the environment.

An EL back-light (including high voltage driver) is included on the TVM24128. The back light can be turned ON and OFF via an on board switch by issuing a command to the TVM24128.

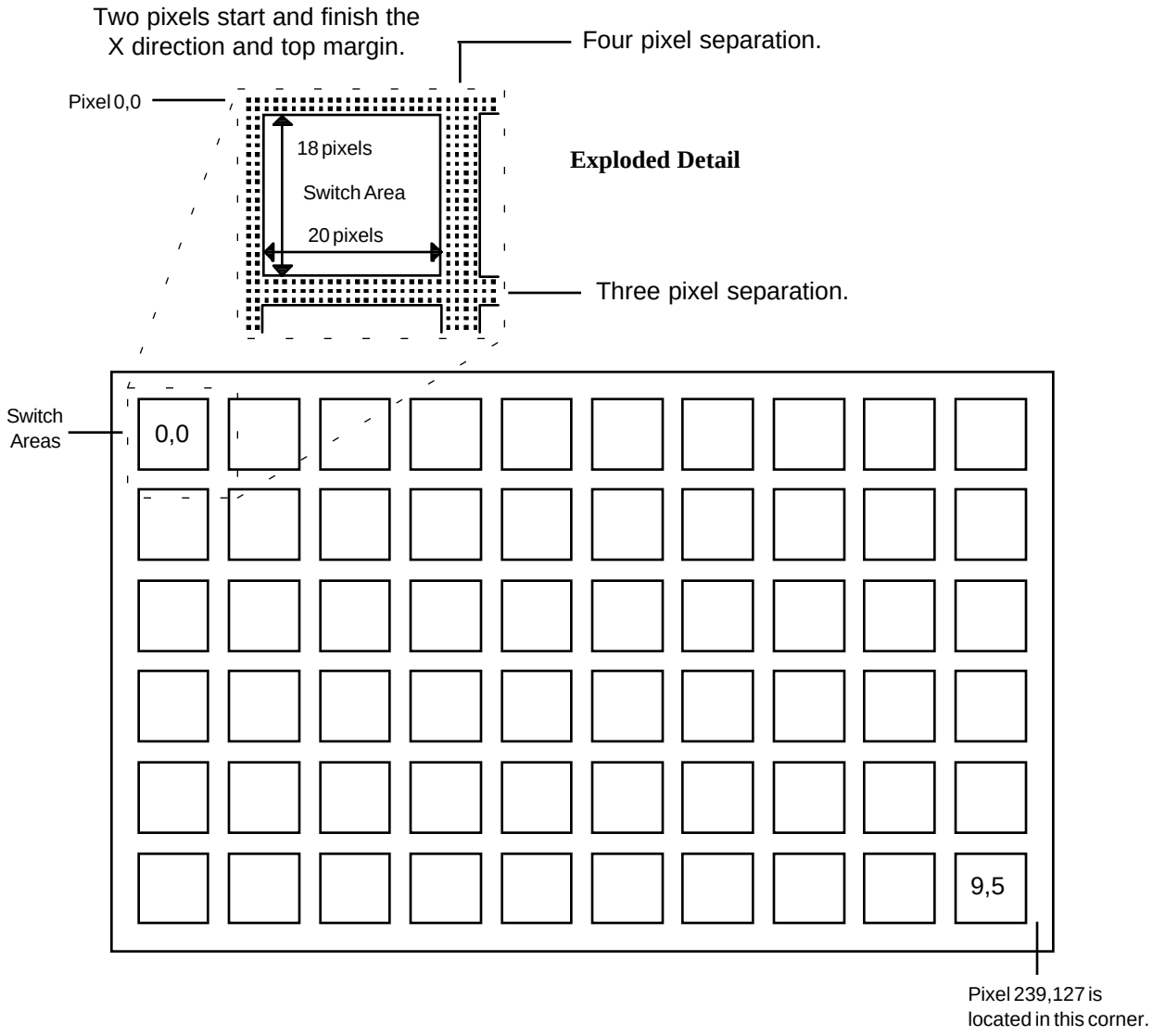
Features:

- 240 X 128 Super Twist LCD Display
- Transmissive or Transflective Versions
- 6 X 10 Matrix Touch Panel Overlay
- Single +5 Volt Power Supply Operation
- 4 Level Gray Scale Capability
- Software Controlled Long Life EL Back Light
- Compact Size
- Software Controlled Electronic Contrast
- 2 Built in Fonts
- Up to 3 Down Loaded Soft Fonts
- Audio Alarm and or Key Click
- 4 Programmable Auxiliary Digital Outputs
- 8 Auxiliary Digital Inputs
- Automatic Scrolling in Text Window
- Freely Mixed Multiple Font Types
- Auto Button Generation and Placement
- An Abundance of Graphics Commands
- 8 Bit Parallel and RS232 Serial Interfaces

Display and Touch Panel Layout

The LCD display is organized in an array 240 dots wide by 128 dots tall. The upper left hand corner of the display is always 0,0 (X,Y). The lower right is 239,127. All coordinates, whether for cursor placement or for placements of graphics use the same coordinate entry methodology and are always referenced to the upper left corner of the display.

The touch panel is organized as an array, 10 wide by 6 tall, of touch sensitive cells. The upper left hand cell is referred to as 0,0 and the lower right cell is 9,5. Each cell is 20 pixels wide by 18 pixels high. A horizontal space 4 pixels wide and a vertical space of 3 pixels is left as an easement between each touch panel cell.



Touch Panel Overlay Detail

Parallel System Interface

Connecting the TVM24128 to the host micro-processor is done via a 20 pin ribbon cable which is connected to JF1 at the bottom of the module. Power and ground are provided to the module through this cable when using the parallel interface. The TVM24128 uses an 8 bit instruction/data bus as well as 2 address lines. There are also several control signals and status lines.

Pin #	Function	Description	Type
1	VSS	VSS Power connection	Power
2	RESET/	Module Reset, Negative	Out
3	DEN/	Module Enable, Negative	In
4	DRD/	Read, Negative	In
5	DWR/	Write, Negative	In
6	DIBF	Input Buffer Full, Positive	Out
7	DOBF/	Output Buffer Full, Negative	Out
8	ERROR	Module Error, Positive	Out
9	KEYPRESS	Key Pressed Flag, Positive	Out
10	DA0	Address 0	In
11	DA1	Address 1	In
12	D0	Data 0	I/O
13	D1	Data 1	I/O
14	D2	Data 2	I/O
15	D3	Data 3	I/O
16	D4	Data 4	I/O
17	D5	Data 5	I/O
18	D6	Data 6	I/O
19	D7	Data 7	I/O
20	VCC	Power	Power

JF1 Connections

Instructions for the TVM24128 are always written to address 0. If the instruction requires additional data, the data is written to address 1. This is done to facilitate data strings of arbitrary length such as text input or down loading of fonts. String data is always terminated by writing the next instruction to address 0. Instructions having data of an arbitrary amount are referred to as having “String” data.

Any instruction requiring more data before it can execute may be aborted by writing the next instruction to the instruction register.

Some instructions will return data which is always read at address 0. The status register may be read at any time from address 3. The table below summarizes the address mapping.

DA1	DA0	Write	Read
0	0	Instruction	Data
0	1	Data	
1	0		
1	1		Status

Address Mapping

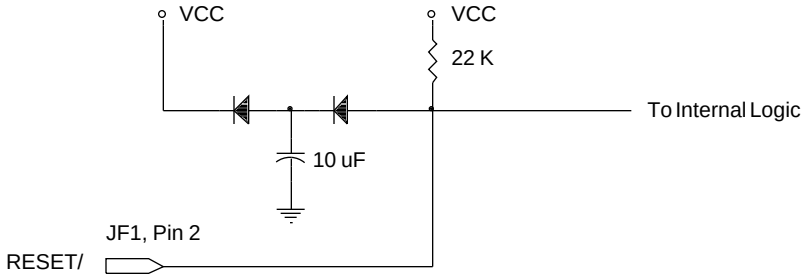
Signal Descriptions

DEN/	DWR/	DRD/	DA0	DA1	Action
1	x	x	x	x	No Action
0	1	1	x	x	No Action
0	0	1	0	0	Write Instruction
0	0	1	1	0	Write Data
0	0	1	0	1	Illegal
0	0	1	1	1	Illegal
0	1	0	0	0	Read Data
0	1	0	1	0	Illegal
0	1	0	0	1	Illegal
0	1	0	1	1	Read Status Register

Interface Signals

RESET/

A logic 0 level on this pin causes a reset of the module. If this pin is left open, the internal RC reset network on the module will cause a reset. It should be noted that the internal capacitor in the TVM24128 will hold down the RESET/ line and any external circuitry tied to the this pin. It is important that sufficient time be allocated to allow the TVM24128 to complete reset and start up prior to receiving instructions from the host processor.



Reset Circuit Diagram

DEN/, DRD/, DWR/

A logic 0 level on DEN/ and DWR/ will cause a write to the TVM24128. A logic 0 level on DEN/ and DRD/ will cause a read from the TVM24128. Please refer to page 4 for DA0 and DA1 addressing information.

DIBF (Input Buffer Full)

The TVM24128 uses an 8255 PPI device to act as an I/O buffer to the controller. Instruction and data information is always written to this buffer. The I/O buffer can hold information for the next instruction while the controller processes the current instruction so there is one level of pipe lining of data to the module. This is an important point to remember when interfacing the module. DIBF provides a signal to indicate if the TVM24128 can accept data. A logic 0 indicates that the TVM24128 is ready for the next instruction or data. A logic 1 indicates that the input buffer to the controller is full and the module is busy. Therefore, the DIBF signal does not indicate that the controller has completed execution of the current instruction, it only indicates that the input buffer is empty and that new information may be written. DIBF can also be read through the status register.

DOBF/ (Output Buffer Full)

A logic 0 on DOBF/ indicates that the controller has placed data into the I/O buffer to be read by the external microprocessor. As soon as the data is read, the DOBF/ line returns to a logic 1. DOBF/ can also be read through the status register. DOBF/ will stay set until the data is read from the TVM24128 or until the reset line is pulled low. i.e. if a user program requests information, but never takes this information, the DOBF/ flag will remain set. When the next request for information is made,

the main program will detect the DOBF/ flag set and immediately retrieve the previous instruction's information. To avoid this problem, be sure to always read the output register when the DOBF/ flag is set .

ERROR

Because of the intelligent nature of the TVM24128, some instructions may cause an error if they can not be executed. One cause may be providing the instruction with data that produces an internal error. An example would be trying to place a button on top of another button. The second button would not be placed and the ERROR flag would be set to a logic 1. It will stay set until the next instruction is executed. The ERROR flag has different meanings depending on the instruction being executed. Please refer to Section 2 for the specific ERROR flag meaning for each instruction. ERROR can also be read through the status register.

KEYPRESS

The KEYPRESS flag indicates that a button has been pressed and that the external micro-processor may now read the "Button Code". This code indicates which button has been pressed. The "Button Code" is assigned to a button when it is placed on the display. More information can be found in section 3.6.1 of the Designer's Manual. KEYPRESS can also be read through the status register.

DA0, DA1

DA0 and DA1 are used to address the different module registers. Please refer to the table on page 4 for more information.

D0 - D7

D0 through D7 forms the 8 bit bi-directional data buss to the module.

Status Register

In some applications you may prefer to read a status register rather than use "hardware hand shaking". A status register is provided on the TVM24128 which stores the "hand shaking" signals previously described. The status register can be read at address 3 at any time without affecting the writing or reading of instructions or data. See the table below for more information.

The status register has a signal, CPUBUSY, that can be used to indicate whether or not the CPU is executing the current instruction. This flag is set high when an instruction is loaded into the instruction register (address 0) and stays set high until the instruction is completed.

Bit	Function
0(LSB)	DIBF
1	DOBF/
2	ERROR
3	KEYPRESS
4	CPUBUSY
5	0
6	0
7(MSB)	0

Status Register Bit Functions

Auxiliary Control Port

The auxiliary control port, labeled JD1 on the back view of the TVM24128, enables access to 4 open collector NPN outputs and 8 CMOS digital inputs via the Write Aux Port and Read Aux Port instructions. The inputs are normally pulled up to Vcc through 22K Ohm resistors. The pin functions of JD1 are listed below. A logic one sent to an output turns the appropriate open collector transistor on to pull to ground.

Pin Number	Description	Pin Type
1	Vss	Power
2	Aux In 7	Input
3	Aux In 6	Input
4	Aux In 5	Input
5	Aux In 4	Input
6	Aux In 3	Input
7	Aux In 2	Input
8	Aux In 1	Input
9	Aux In 0	Input
10	Aux Out 3	Output
11	Aux Out 2	Output
12	Aux Out 1	Output
13	Aux Out 0	Output
14	Vcc	Power

JD1 Auxiliary Port Connections

RS232 Serial Interface

In addition to a parallel interface, the TVM24128 includes an RS232 interface which uses a programming language called TVSGL (Touch Vision Serial Graphics Language). With only a few exceptions, all commands and data are given as simple ASCII strings, similar to those produced by a terminal. As an example, to move the cursor to a new position using the parallel interface you would issue the SetXY command plus give the position in binary code to the input port. Using TVSGL, the command would be the simple ASCII string CS50,100 which would position the cursor at the 50/100 display co-ordinate.

Special characters, described in detail later, are used to control the hand shaking protocol and status information.

Basic Command Structure

Serial commands are two characters long. After a serial command is issued, data is provided by giving the ASCII string equivalent of the numeric value required. Data values are separated by a comma (,) or a space ( ). A carriage return can also be used to separate instructions and data. The following examples are valid means of issuing the same command:

```
CS 50,100
CS50,100
CS 50 100
CS
50
100
```

Commands can be given in a free format with only a few rules governing syntax. The TVM24128 software will lexically analyze the input string and interpret the instruction prior to execution.

Command Options and Attributes

Some commands require attributes that are embedded into the parallel instruction OP code. When using the serial interface, these attributes are presented separately following the two letter serial command code. The example below illustrates this:

```
        FD4,5,7,0,48,data,data,data,data  ...
or      FD4 5 7 0 48 data data data data ...
```

Down load to font 4, SizeX = 5, SizeY = 7, Descenders = 0, Offset = 48

Special Binary Data

Some command data in most efficiently sent to the TVM24128 by transmitting binary data directly to the module. This approach is convenient, for instance, when down loading font data. Because binary data can represent any value including special ASCII control characters, a special mode can be entered into to allow sending of this data without conflicts. This mode is entered into by sending an exclamation point "!" prior to any binary data. The module will then receive the next 256 data bytes as binary data without exception. Font data, loaded via this technique, is done so by quantizing the data into packets of 256 bytes. When less than 256 bytes are to be sent, the remainder of the packet is padded with zeros. The example below shows this:

FD4,5,7,0,48!<256 byte packet>!<256 byte packet>

Quoted Strings

ASCII string data such as that given when using the Input String instruction must be contained within quotes. Any printable ASCII character can be placed within the quotes. The following are examples of strings:

String as given to module	String as printed
"This is a string"	This is a string
"This \"This\" is quoted"	This "This" is quoted
"This \\\"This\"\\ is quoted"	This \"This"\ is quoted

Note that a back-slash escapes the quote allowing it to be printed and not delimit the string. A back-slash is printed by sending two consecutive back-slashes.

```
To print:    a ",    provide a \"
To print:    a \,    provide a \\
```

Returned Data Format

Some commands require data to be returned from the TVM24128 to the host. These data strings are always proceeded by a dollar ($) sign. The following example shows a query to return the length of a button area:

```
Sent to module:      BS5      Ask length of button 5
Returned by module:  $2\n     It is 2 cells long.
```

The following asks for the current XY position:

```
Sent to module:      CS
Returned by module:  $50,100\n
```

The \n character represents a carriage return. It is always appended at the end of a returned string.

Instruction Errors

Some commands can cause an error condition upon execution. In this case the module will return the pound sign "#" followed by the instruction string that failed. The following example queried the module for the length of a button that had not yet been placed:

Send to module:	BS 5
Returned by module:	#BS$2\n

Asked for length of button with code 5. What returned was the error (#) plus the length information which would be two based on buffer information.

Serial data buffer

The TVM24128 contains a 1024 byte serial data buffer. Commands and data which are sent to the module are stored in this buffer prior to being executed. Thus, commands and data can be sent faster than the module can execute each instruction. When using high baud rates and without safeguards, this buffer could eventually overflow causing a loss of data. To prevent buffer overflow, the TVM24128 supports both the RTS/CTS hardware hand shaking protocol and the XON/OFF software hand shaking protocol. The buffer hand shaking is determined through the use of the @H, @L, @X and @R instructions described later.

Default Hand Shaking Protocol

The TVM24128 default serial protocol is RTS/CTS with XON/XOFF software protocol disabled. Typically, the host system software would setup the module operating modes and protocol early in the program. It should be noted however, that regardless of what protocol is selected or enabled, the module will respond to commands and return appropriate data. The hand shaking protocol is used only to manage the contents of the serial data buffer. Some applications may not require hand shaking protocol to be used at all.

Serial Interface Commands

Special commands are provided to allow the host system to control the serial interface of the TVM24128. All of these commands are proceeded by the "@" symbol followed by a single character command and optional data.

@K Key press query

Sending the @K command will cause the TVM24128 to return the current keypress status.

Send to module:	@K	
Returned:	@K1	if key press
Returned:	@K0	if not key press

@E Echo String

In some cases, the controlling system must know what instruction the TVM24128 is executing. A method to obtain this information is required since the TVM24128 can buffer as much as 1K bytes of operational data. If a given instruction is inclined to generate an error, the controlling host needs to know when it is executed. The host can then correlate the returned error codes to a particular instruction. The feedback can be generated by following error prone instructions with an @E command. When the host receives the echo string back from the module, the host knows that any error codes received immediately prior where created by the echoed instruction.

Echo capability enables the host to send a block of serial commands as fast as possible and then wait for an appropriate echo before proceeding. The echo string can be of any length but must contain only numbers or letters (alpha numeric) and must not be quoted. The following shows an example of the @E command:

Sent to module	Received from module
@E100	@E100
@EEchoThis	@EEchoThis

@H @L Set High Threshold, Set Low Threshold

@H and @L are used to set the high and low buffer threshold points. The thresholds are used to determine when to change the CTS (clear to send) signal and when to send the XON/XOFF characters. The default high threshold is set at 800 bytes. The default low threshold is set at 200 bytes. Upon the buffer contents falling below the @L threshold mark, the CTS signal goes high. If XON/OFF is selected, the XON (DC1 or 0x11 hex) character is sent to the host. When the buffer contents rise above the @H threshold mark, the CTS signal goes low. If XON/OFF is selected, the XOFF (DC3 or 0x13 hex) character is sent to the host. Following are examples of the @H and @L instructions:

@H850	Set high threshold to 850 bytes.
@H650	Set high threshold to 650 bytes.
@L400	Set low threshold at 400 bytes.

@X Enable XON/OFF

Sending @X selects the XON/OFF software hand shaking.

@R Disable XON/OFF

Sending @R disables the XON/OFF software hand shaking.

@S @D Enable/Disable KPS

The TVM24128 can automatically send a special code to the host whenever a key is pressed. This signal, called the KPS signal, is the same as DC2 (0x12 hex). If @S is sent to the module, it enables the module to automatically send the KPS signal when a key is pressed. This allows the host system to interrupt what it is doing and service the keyboard without the host continuously polling the module using the @K command.

The @D command disables the KPS feature.

RS232 Interface Description

The RS232 hardware connections are made via a 10 pin shrouded header (JA5). The pins are ordered as is a DCE (modem). The TVM24128 requires a straight through cable connection often referred to as a “NULL MODEM”.

Serial Data Protocol

All serial data communication uses 8 bit, NO parity and 1 stop bit protocol.

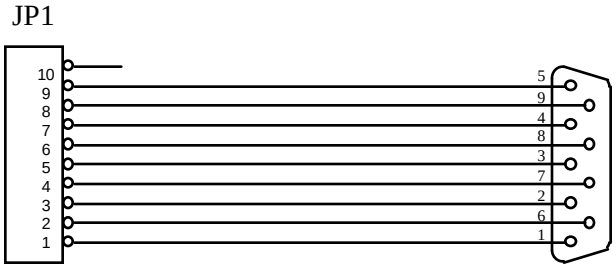
Signal Names

The table below and following figure show the RS232 connector pin designations:

Pin #	Function	Description	Type
1	Ground	Ground connection	
2	Ground	Ground Connection	
3	TD	Transmit Data	Output
4	RTS	Request to send	Input
5	RD	Receive Data	Input
6	CTS	Clear to send	Output
7	N/C	No connection	
8	Ground	Ground Connection	
9	Ground	Ground Connection	
10	N/C	No connection	

JA5 RS232 Port Connections

The connector pins are ordered in such a way that a simple adapter can be made converting the 10 pin connector to a 9 pin D-SUB connector typically used on compatible PC's. A wiring diagram for the cable follows:



10 PIN Header to 9 pin D-SUB PC RS232 Cable

Signal Description

Following is a description of the RS232 signals.

TD This is the TVM24128 transmitter output.

RD Receives data from the host processor.

RTS The signal provided by the host system to tell the module it is ready to send data. The module will then raise the CTS signal if the buffer is below the full threshold. As long as RTS stays low, the TVM24128 will not raise the CTS signal. Tieing this line high (+5 V) will permanently enable the CTS signal to indicate the current buffer status.

CTS This signal provided by the TVM24128 tells the host system that it is ready to receive data. If the TVM24128 buffer is below the high threshold when RTS goes high, CTS will go high. Upon the buffer filling above the high threshold, CTS will go low and stay low until the buffer contents fall below the low threshold. If RTS is taken low and high again, the module will re-evaluate the buffer status and raise the CTS signal if the buffer is below the high threshold. CTS can not go high unless RTS is also high.

If software hand shaking is employed, both CTS and RTS can be left disconnected.

Baud rate selection

The TVM24128 can operate at any of 8 baud rates. The baud rate is selected by the module at the time reset occurs by reading the baud rate jumpers JO1, JO2 and JO3. A shorting clip between the center pin and pin 3 programs the baud jumper to a logic one. The table below shows the available baud rates and associated jumper combinations:

The baud rate is only set during reset.

Baud Rate	JO1	JO2	JO3
300	0	0	0
600	0	0	1
1200	0	1	0
2400	0	1	1
4800	1	0	0
9600	1	0	1
19200	1	1	0
38400	1	1	1

Baud Rate Jumper Selection

Mixed Mode Operation

The TVM24128 has the unique ability to operate in a combined parallel and serial mode. Commands and data from both the serial and parallel interface can be received as long as commands do not overlap due to simultaneous transmission by the host or hosts. If the operational data overlaps, the module will mix and match serial and parallel commands and data and execute a composite of both. This will result in some unpredictable behavior.

Instruction Set Summary

	Parallel Instruction	Serial Instruction
Font Selection		
Select Font	00000xxx	FS{xxx}
Down Load Font	00001xxx,SizeX,SizeY,Offset,Descenders String...	FD{xxx},{SizeX},{SizeY},{Offset},{Descenders}, !<256 byte packet>!<256 byte packet> ...
Set Font Attributes	000110ab	FA{ab}
Select Font Gray Palet	1011AABB	FG{AABB}
Set Font Plane	0001001x	FP{x}
Cursor Positioning		
SetXY	00100000,Xpos,Ypos	CS{XPos},{YPos}
ReadXY	00100001,[Xpos],[Ypos]	CG [${XPos},{YPos}\n]
Cursor Up	00100010	CU
Cursor Down	00100011	CD
Cursor Left	00100100	CL
Cursor Right	00100101	CR
SetX	00100110,Xpos	CX{XPos}
SetY	00100111,Ypos	CY{YPos}
Set Cursor Attributes	00010abc	CA{abc}
Text Configuration		
Set Text Window	00101000,AX,AY,BX,BY	TW{AX},{AY},{BA},{BY}
Set Pitch	00101010,Pitch	TP{Pitch}
Set Height	00101011,Height	TH{Height}
Text Input		
Input String	00101100,String...	IS"Quoted String"
Graphics Input		
Draw Box	0100TTTF,AX,AY,BX,BY	GX{TTTF},{AX},{AY},{BX},{BY}
Draw Block	011000TT,AX,AY,BX,BY	GB{TT},{AX},{AY},{BX},{BY}
Draw Horiz	011001TT,Xpos,Ypos,Length	GH{TT},{XPos},{YPos},{Length}
Draw Vert	011010TT,Xpos,Ypos,Length	GV{TT},{XPos},{YPos},{Length}
Draw Vector	011011TT,AX,AY,BX,BX	GC{TT},{AX},{AY},{BX},{BY}
Set Pixel	011100TT,Xpos,Ypos	GI{TT},{XPos},{YPos}
Set Gray Palet	1100AABB	GG{AABB}
Set Graphics Plane	0111100x	GP{x}
Button Input		
Place Button	00110000,KeyCode,0RRRCCCC	BC,{KeyCode},{RRRCCCC}
Load Button Buffer	00110001,String...	BL"Quoted String"
Get Button Size	00110010,KeyCode,[RData]	BS [${Size}\n]
Place Phantom Butt.	00110011,KeyCode,0RRRCCCC,BLength	BH,{KeyCode},{RRRCCCC},{BLength}
Delete Button	00110100,KeyCode	BD{KeyCode}
Delete All Buttons	00110101	BE
Read KeyCode	00110110,[RData]	BK [${KeyCode}\n]
Set Button Attributes	00111abc	BA{abc}
Set Button Gray Palet	1101AABB	BG{AABB}
Set Button Plane	1110000x	GP{x}

Instruction Set Continued

Display Control

	Parallel Instruction	Serial Instruction
Blank Display	10000000	DB
Clear Display	10000111	DC
Dump Display RAM	10000100,[RData...]	Not Available
Load Display RAM	10000101,String...	Not Available
Move Block Vert	01110100,AX,AY,BX,BY,Distance	DV{AX},{AY},{BX},{BY},{Distance}
Move Block Horiz	01110101,AX,AY,BX,BY,Distance	DH{AX},{AY},{BX},{BY},{Distance}
Load Gray Dither	10000010,GD1,GD2	DD{GD1},{GD2}
Reverse Video Mode	1000110R	DR{R}

System Instructions

Soft Reset	11111110	SR
Set Contrast	11110011,Data	SC{Data}
Set EL	1111010a	SE{a}
NOP	11111111	SN
Set Beeper	1111000a	SB{a}
Read Key Matrix	11110010,[RData (12 bytes total)]	SK [${byte 1},{byte 2}, ... ,{byte 12}\n]
Write Aux Port	11111000,0000xxxx	SW{xxxx}
Read Aux Port	11110111 [AuxData]	SA [${Aux Data}\n]

Serial Interface Instructions

The following instructions are used in serial interface applications.

Name	Instruction	Description
Query Keypress	@K	Returns @K1 if Keypress is set, @K0 if not.
String Echo	@E{alpha num string}	Echoes the alpha numeric string sent.
Set Buffer High Thresh.	@H{number}	Sets the receive buffer high threshold.
Set Buffer Low Thresh.	@L{number}	Sets the receive buffer Low threshold.
Enable XON/XOFF	@X	Turns on the XON/XOFF hand-shaking protocol.
Disable XON/XOFF	@R	Turns off the XON/XOFF.
Enable KPS	@S	Enable KPS when a key is pressed. KPS is DC2 (0x12).
Disable KPS	@D	Disables KPS.

Power Supply Considerations

When using the TMV24128 with the parallel interface, power and ground is generally supplied via the power pins of the connector JF1. The RS232 power connector can optionally be used to supply power and ground if desired.

The serial interface requires that power and ground be supplied via the RS232 power connector if the parallel cable is not being used simultaneously.

The metal bezel is connected to ground via a top-side trace located near the RS232 power connector. The trace is clearly marked in the metal layer itself. If desired, the bezel can be connected to a separate ground by cutting the marked trace and connecting the pad closest to the edge of the board to an external ground.

If an external EL power supply is desired, the shunt across pins 2 and 3 of header JO6 can be removed and power can be supplied via pin 2 (Positive) and pin 1 (Ground) of the same header.

DC Electrical Characteristics:

V_{CC} = 5.0V ± 5% unless otherwise specified.
T_A = 25 °C Unless otherwise specified.

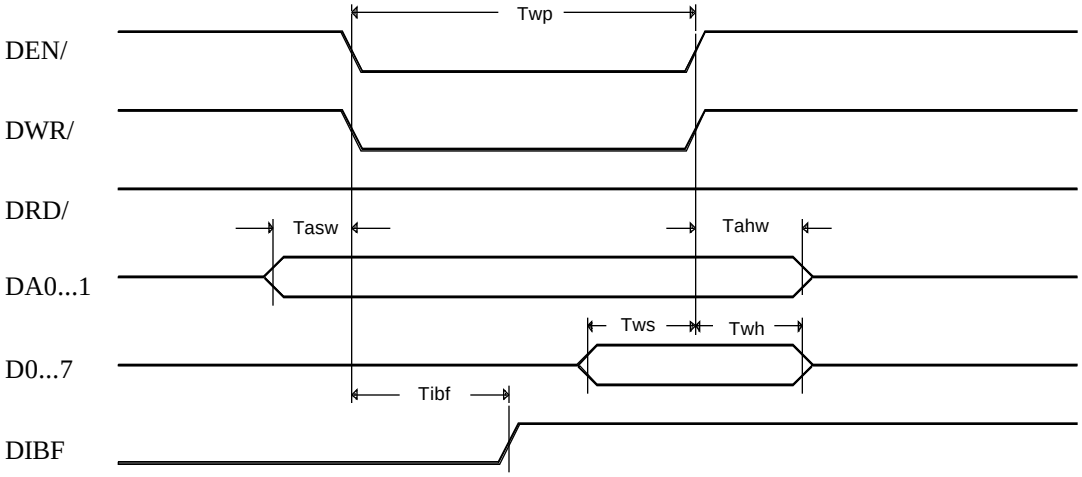
Parameter	Min	Typ	Max	Units	Conditions
Power Supply Voltage Supply Current, Back-light OFF Back-light ON	4.75	 175 450	5.25 210 500	Volts mA mA	 Vcc = 5.0 Volts
VIL Input Low Voltage D7-D0,DA1,DA0,DWR/,DRD/,DEN/,Aux inputs	- 0.5		0.8	Volts	
VIH Input Hi Voltage D7-D0,DA1,DA0,DWR/,DRD/,DEN/, Aux inputs	2.0		V_{CC}	Volts	
VOL Output Low Voltage D7-D0,DBUSY,DREADY/,ERROR,KEYPRESS			.4	Volts	IOL = 2.5 mA
VOH Output Hi Voltage D7-D0,DBUSY,DREADY/,ERROR,KEYPRESS	3.0 Vcc - .4			Volts Volts	IOH = -2.5 mA IOH = -100 uA
IOZ Output Floating Leakage D0-D7	± 50		± 300	uA	VIN = Vcc or 0 Volts
IOL Output Current Auxiliary Outputs	50			mA	VOH = .5 Volts
$\overline{\text{RESET}}$ (Active Low) $\overline{\text{RESET}}$ (Inactive Hi)	 4.5		.5	Volts Volts	22K Pull Up
External EL Supply Voltage External EL Supply Current	3.0		5.5 200	Volts mA	
RS232 Port Specifications					
Input Voltage Operating Range	- 30		+30	Volts	
Input Threshold Low	0.8		1.2	Volts	
Input Threshold High		1.7	2.4	Volts	
Input Hysteresis	0.2	0.5	1.0	Volts	
Input Resistance	3	5	7	kOhms	
Output Voltage Low		- 9.0	- 5.0	Volts	IOUT = 3.2 mA
Output Voltage High	5.0	9.0		Volts	IOUT = 1.0 mA
Instantaneous Slew Rate			30	V/uS	CL = 10 pF, RL = 3-7 kOhms
Transition Region Slew Rate		3		V/uS	CL = 2500 pF, RL = 3 kOhms
Output Resistance	300			Ohms	VOUT = ± 2 Volts
Output Short Circuit Current		± 10		mA	

AC Electrical Characteristics

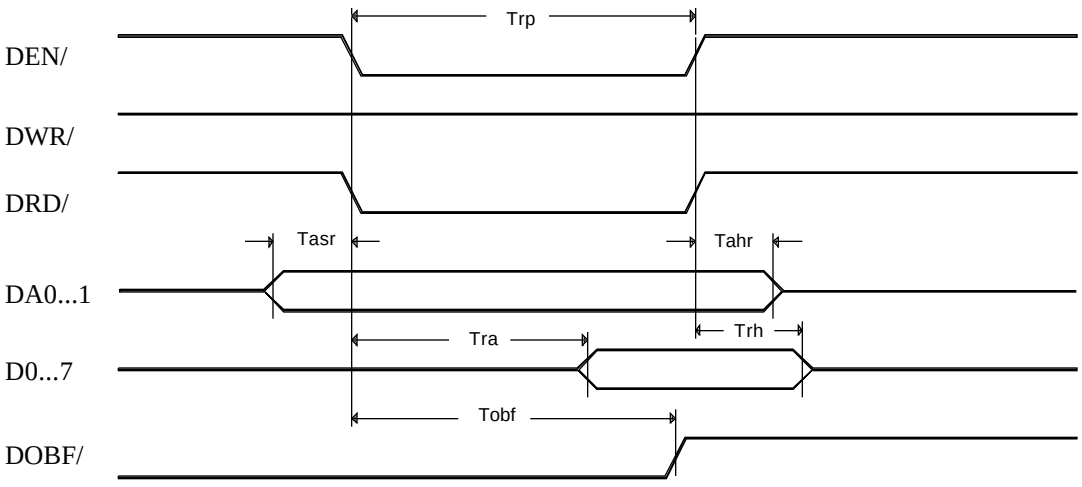
V_{CC} = 5.0V ±5% unless otherwise specified
T_A = 25 °C Unless otherwise specified

Symbol	Parameter	Min	Max	Units
T_{wp}	Write Pulse Width	100		nS
T_{asw}	Address Setup Write	5		nS
T_{ahw}	Address Hold Write	50		nS
T_{ws}	Write Data Setup	20		nS
T_{wh}	Write Data Hold	60		nS
T_{ibf}	Write to IBF High		100	nS
T_{rp}	Read Pulse Width	100		nS
T_{asr}	Address Setup Read	5		nS
T_{ahr}	Address Hold Read	0		nS
T_{ra}	Read Data Access		100	nS
T_{rh}	Read End to Data Tri-state		50	nS
T_{obf}	Read to OBF High		100	nS

Timing Waveforms

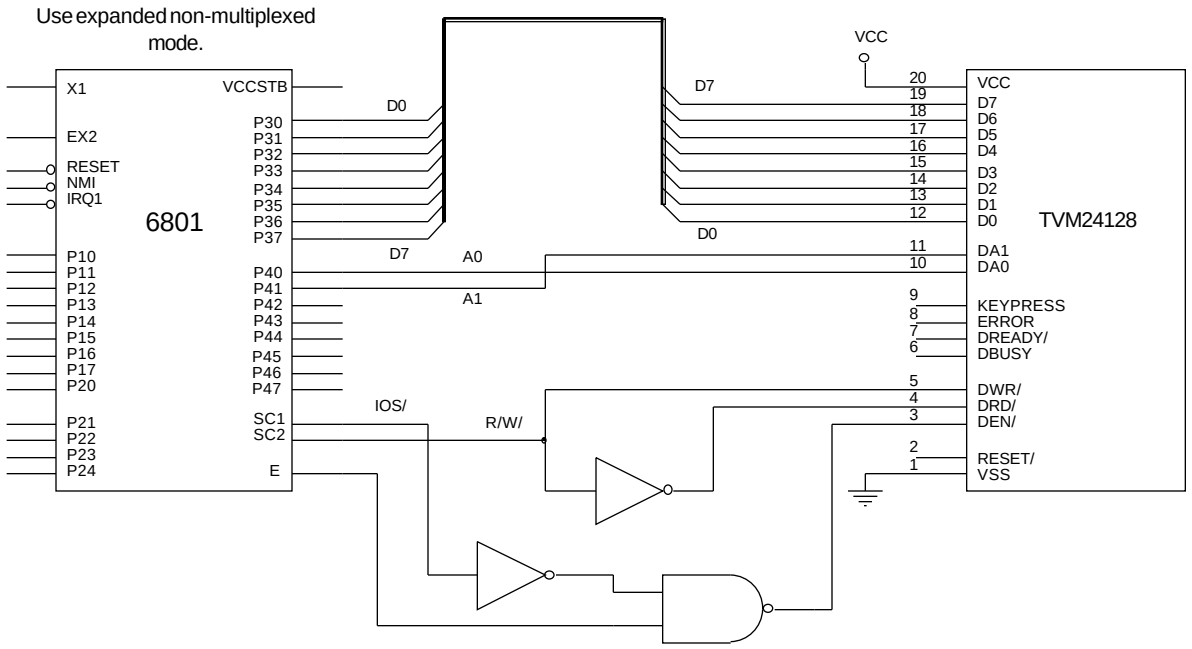


Write Cycle Timing

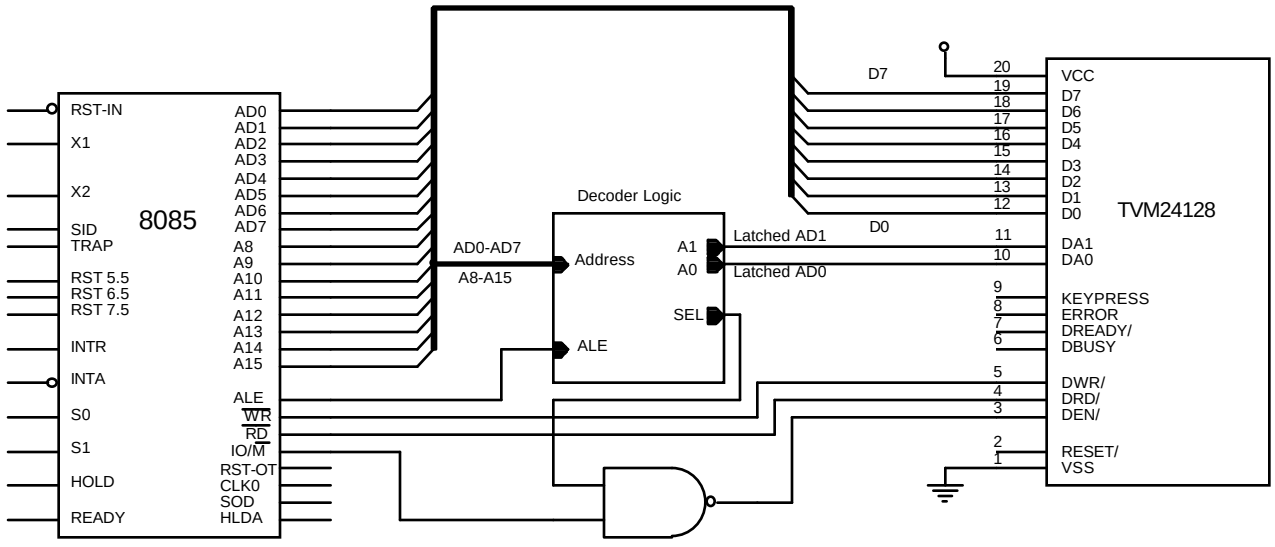


Read Cycle Timing

Parallel Interface Examples



6801 Parallel Interface Example

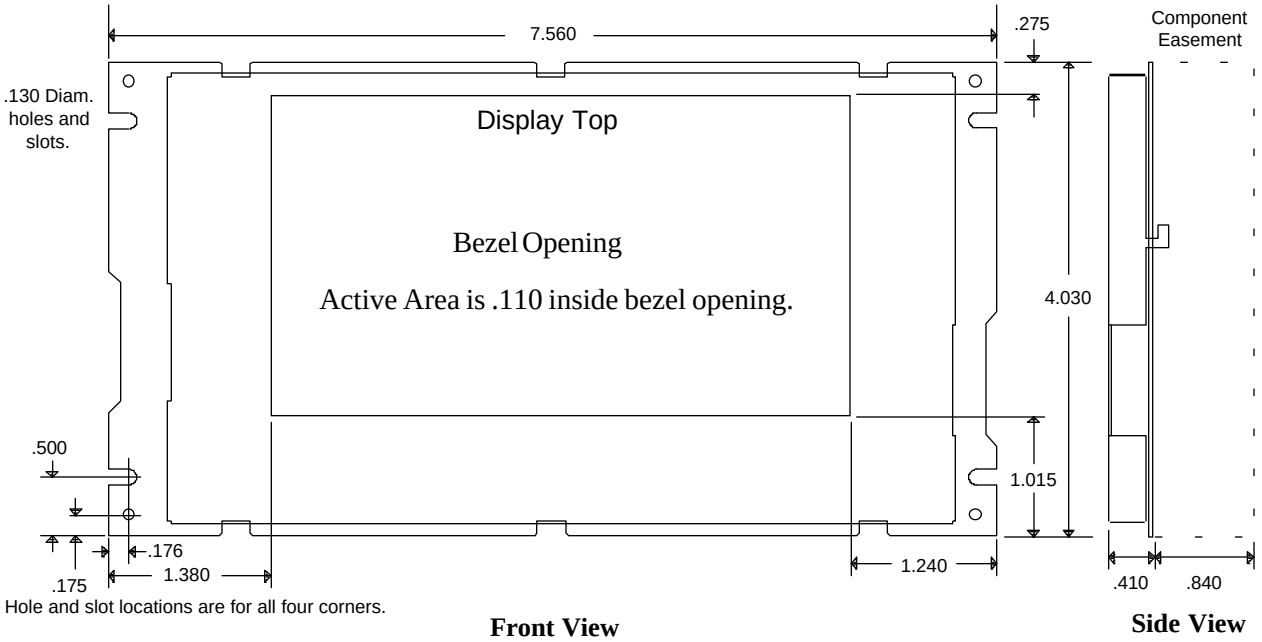


8085 Parallel Interface Example

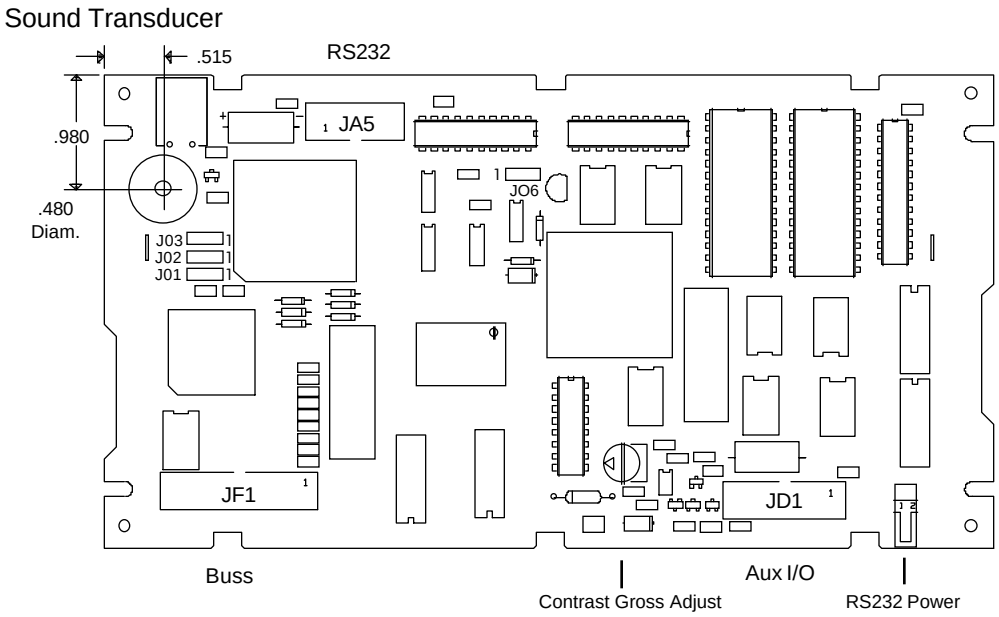
Additional Information

Applications information plus expanded information on the instruction set can be found in the TVM24128 Designer's Manual. If you need additional technical information, please contact C Sys Labs.

Mechanical Outlines:



Front View **Side View**



Back View

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