

# DATA SHEET

**83C145; 83C845**

**83C055; 87C055**

**Microcontrollers for TV and video  
(MTV)**

Product specification  
File under Integrated Circuits, IC20

1996 Mar 22

**Microcontrollers for TV and video (MTV)****83C145; 83C845  
83C055; 87C055**

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### 1 FEATURES

- Masked ROM sizes:
  - 8 kbytes (83C845)
  - 12 kbytes (83C145)
  - 16 kbytes (83C055)
  - 16 kbytes OTP (87C055)
- RAM: 256 bytes
- On Screen Display (OSD) controller
- Three digital video outputs
- Multiplexer/mixer and background intensity controls
- Flexible formatting with OSD New Line option
- 128 × 10 bits display RAM
- Designed for reduced Radio Frequency Interference (RFI)
- Character generator ROM:
  - character format 18 lines × 14 dots
  - 60 visible characters
  - 4 special characters
- Eight text shadowing modes
- Text colour selectable per character
- Background colour selectable per word
- Background colour versus video selectable per character
- Eight 6-bit Pulse Width Modulators (PWM) for analog voltage integration

- One 14-bit PWM for high-precision voltage integration
- Digital-to-analog converter and comparator with 3 inputs multiplexer
- Nine dedicated I/Os plus 28 port bits (15 port bits with alternative uses)
- 4 high current open-drain port outputs
- 12 high voltage (+12 V) open-drain outputs
- Programmable video input and output polarities
- 80C51 instruction set
- No external memory capability
- Plastic shrink dual in-line package (0.07 inch centre pins)
- High-speed CMOS technology
- Power supply: 5 V ±10%.

### 2 DESCRIPTION

The 83C055, Microcontroller for Television and Video (MTV) applications, is a derivative of Philips' industry standard 80C51 microcontroller.

The 83C055 is intended for use as the central control mechanism in a television receiver or tuner.

### 3 APPLICATIONS

Providing tuner functions and an OSD facility, it represents a next generation replacement for the currently available parts.

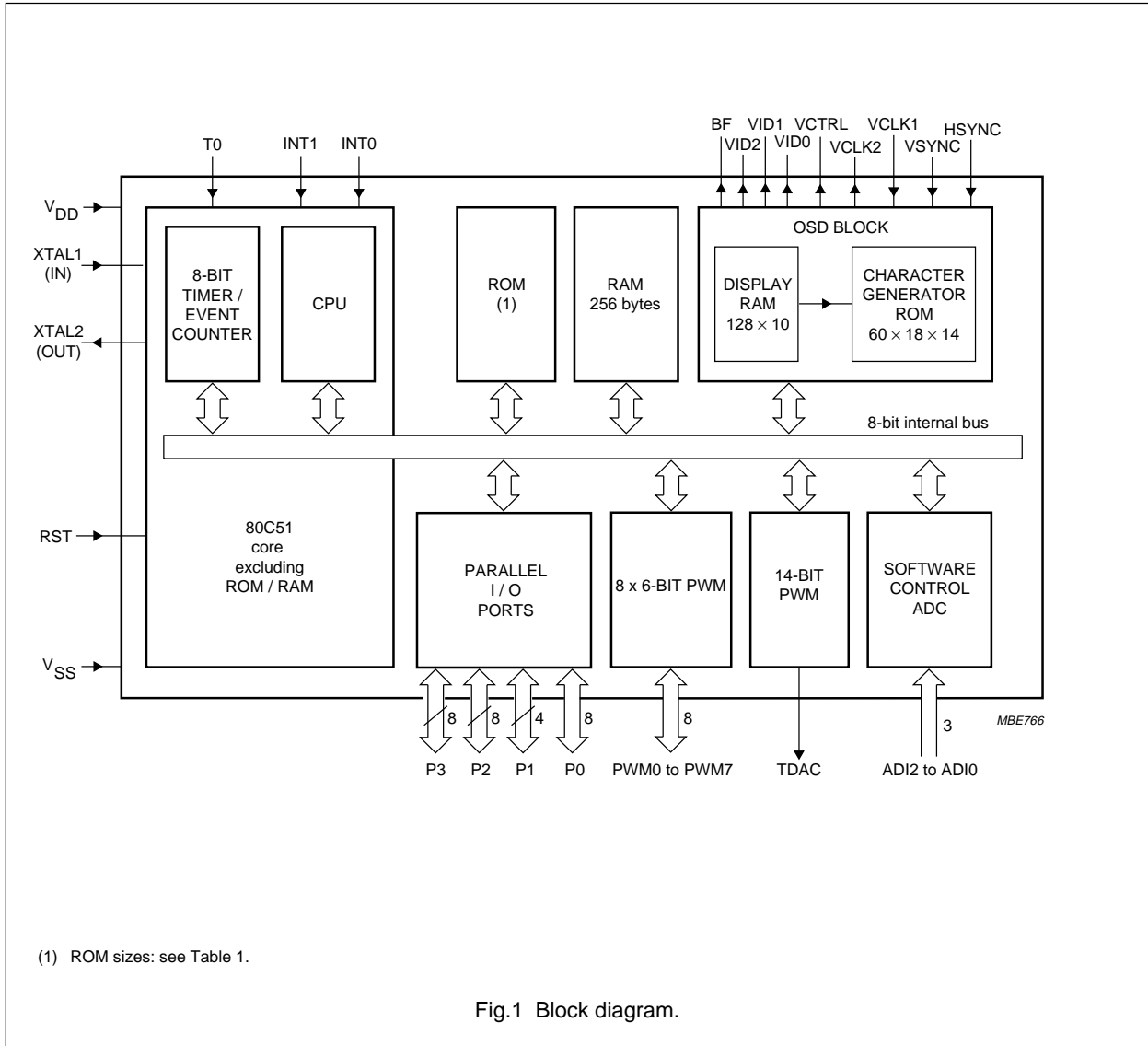
### 4 ORDERING INFORMATION

TYPE NUMBER	PACKAGE			TEMP. RANGE (°C)	FREQ. (MHz)
	NAME	DESCRIPTION	VERSION		
P83C055BBP	SDIP42	plastic shrink dual in-line package; 42 leads (600 mil)	SOT270-1	0 to +70	3.5 to 12
P87C055BBP					
P83C145BBP					
P83C845BBP					

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5 BLOCK DIAGRAM



5.1 Part options

Table 1 Differences between the types

MEMORY	TYPES			
	83C845	83C145	83C055	87C055
ROM	8 kbytes	12 kbytes	16 kbytes	–
EPROM (OTP)	–	–	–	16 kbytes

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6 PINNING INFORMATION

6.1 Pinning

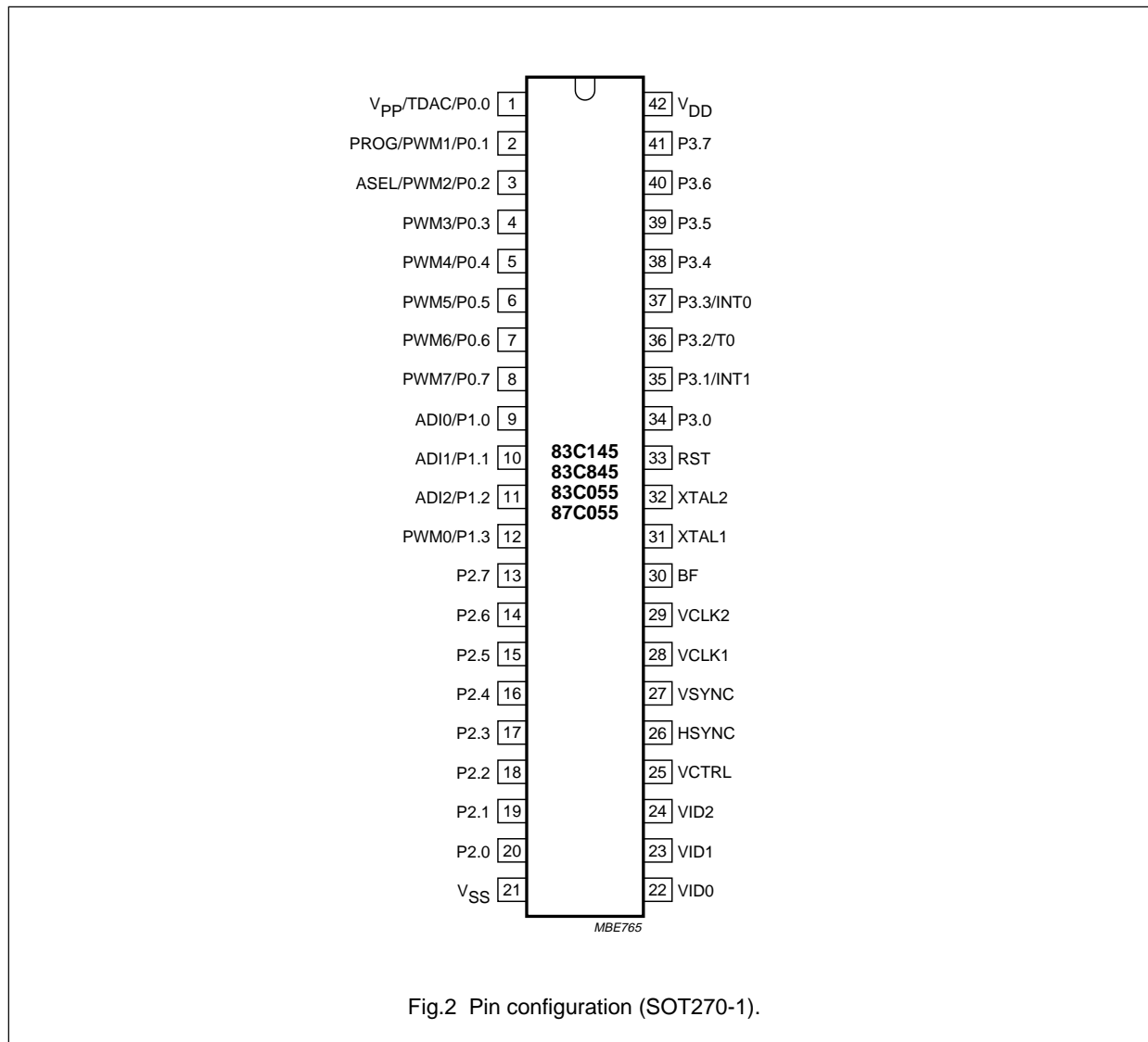


Fig.2 Pin configuration (SOT270-1).

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## 6.2 Pin description

Table 2 Pin description SDIP42 (SOT270-1)

SYMBOL	PIN	DESCRIPTION
<b>Port 0</b> (notes 1, 2 and 4)		
P0.0/TDAC/V <sub>PP</sub>	1	<b>P0.0</b> : open-drain bidirectional port line; <b>TDAC</b> : output for the 14-bit high-precision PWM; <b>V<sub>PP</sub></b> : 12 V programming supply voltage during EPROM programming.
P0.1/PWM1/PROG	2	<b>P0.1</b> : open-drain bidirectional port line; <b>PWM1</b> : output for the 6-bit lower-precision PWM; <b>PROG</b> : input for EPROM programming pulses.
P0.2/PWM2/ASEL	3	<b>P0.2</b> : open-drain bidirectional port line; <b>PWM2</b> : output for the 6-bit lower-precision PWM; <b>ASEL</b> : input indicating the EPROM address bits that are applied to Port 2.
P0.3/PWM3 to P0.7/PWM7	4 to 8	<b>P0.3 to P0.7</b> : 5 open-drain bidirectional port lines; <b>PWM3 to PWM7</b> : 5 outputs for the 6-bit lower-precision PWM.
<b>Port 1</b> (notes 1, 2 and 5)		
P1.0/AD10 to P1.2/AD12	9 to 11	<b>P1.0 to P1.2</b> : 3 open-drain bidirectional port lines; <b>AD10 to AD12</b> : inputs for the software analog-to-digital facility.
P1.3/PWM0	12	<b>P1.3</b> : open-drain bidirectional port line; <b>PWM0</b> : output for the 6-bit lower-precision PWM. PWM0 can be externally pulled up as high as +12 V ±5%
<b>Port 2</b>		
P2.7 to P2.0	13 to 20	<b>Port 2</b> : 8-bit open-drain bidirectional port; P2.3 to P2.0 have high current capability (10 mA at 0.5 V) for driving LEDs. Port 2 pins that have logic 1s written to them float, and in that state can be used as high-impedance inputs. Any of the Port 2 pins are driven LOW if the port register bit is written as a logic 0. The state of the pin can always be read from the port register by the program.
<b>Port 3</b> (note 1 and 3)		
P3.0	34	<b>P3.0</b> : open-drain bidirectional port line.
P3.1/INT1	35	<b>P3.1</b> : open-drain bidirectional port line; <b>INT1</b> : External interrupt 1.
P3.2/T0	36	<b>P3.2</b> : open-drain bidirectional port line; <b>T0</b> : Timer 0 external input.
P3.3/INT0	37	<b>P3.3</b> : open-drain bidirectional port line; <b>INT0</b> : External interrupt 0.
P3.4 to P3.7	38 to 41	<b>P3.4 to P3.7</b> : 4 open-drain bidirectional port lines.
<b>General</b>		
V <sub>SS</sub>	21	<b>Ground</b> : 0 V reference.
VID2 to VID0	22 to 24	<b>Digital Video bus</b> : Three totem-pole outputs comprising digital RGB (or other colour encoding) from the OSD facility. The polarity of these outputs is controlled by a programmable register bit (register OSCON; bit Po).
VCTRL	25	<b>Video Control</b> : A totem-pole output indicating whether the OSD facility is currently presenting active video on the VID2 to VID0 outputs. Signal is used to control an external multiplexer (mixer) between normal video and the video derived from VID2 to VID0. The polarity of this output is controlled by a programmable register bit (register OSCON; bit Pc).

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SYMBOL	PIN	DESCRIPTION
HSYNC	26	<b>Horizontal Sync:</b> A dedicated input for a TTL-level version of the horizontal sync pulse. The polarity of this pulse is programmable; its trailing edge is used by the OSD facility as the reference for horizontal positioning.
VSYNC	27	<b>Vertical Sync:</b> A dedicated input for a TTL-level version of the vertical sync pulse. The polarity of this pulse is programmable, and either edge can serve as the reference for vertical timing.
VCLK1	28	<b>VCLK1: Video Clock 1;</b> input for the horizontal timing reference for the OSD facility. <b>VCLK2: Video Clock 2;</b> output from the on-chip video oscillator. VCLK1 and VCLK2 are intended to be used with an external LC circuit to provide an on-chip oscillator. The period of the video clock is determined such that the width of a pixel in the OSD is equal to the inter-line separation of the raster.
VCLK2	29	
BF	30	<b>Background/Foreground:</b> A totem-pole output which, when VCTRL is active, indicates whether the current video data represents a Foreground (LOW) or Background (HIGH) dot in a character. This signal can be used to reduce the intensity of the background colour and thus emphasize the text.
XTAL1	31	<b>XTAL1:</b> Input to the inverting (oscillator) amplifier and clock generator circuit that provides the timing reference for all 83C055 logic other than the OSD facility. <b>XTAL2:</b> Oscillator output terminal for system clock. XTAL1 and XTAL2 can be used with a quartz crystal or ceramic resonator to provide an on-chip oscillator. Alternatively, XTAL1 can be connected to an external clock, and XTAL2 left unconnected.
XTAL2	32	
RST	33	<b>Reset:</b> If this pin is HIGH for two machine cycles (24 oscillator periods) while the oscillator is running, the MTV is reset. This pin is also used as a serial input to enter a test or EPROM programming mode, as on the 87C751.
V <sub>DD</sub>	42	<b>Power supply:</b> for normal and Power-down operation.

**Notes**

- Port 0, Port 1, and Port 3 pins that have logic 1s written to them float, and in that state can be used as high-impedance inputs.
- The state of the pin can always be read from the port register by the program.
- P3.0, P3.4, and P3.7 can be externally pulled up as high as +12 V  $\pm$ 5%; while P3.5 and P3.6 have 10 mA drive capability.
- For each PWM block, a register bit (register PWMn; bit PWN<sub>n</sub>; n = 0 to 7) controls whether the corresponding pin is controlled by the block or by Port 0; Port 0 controls the pin immediately after a reset. Regardless of how each pin is controlled, it can be externally pulled up as high as +12 V  $\pm$ 5%.
- Any of the Port 1 pins are driven LOW if the corresponding port register bit is written as a logic 0, or for P1.3 only, if the TDAC module presents a logic 0.

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### 7 DESCRIPTION OF STANDARD FUNCTIONS

For a description of the standard functions please refer to the "Data Handbook IC20; Section 2: 80C51 Technical Description".

### 8 INPUT/OUTPUT (I/O)

The I/O structure of the 83C055 is similar to the standard I/O structure in the 80C51, except for the points described in Table 5.

### 9 DESCRIPTION OF DERIVATIVE FUNCTIONS

#### 9.1 General description

Although the 83C055 is specifically referred to throughout this data sheet, the information applies to all the devices. The differences to 80C51 features and the derivative functions are described in the following Sections and Chapters.

Figure 1 shows the block diagram of the 83C055.

##### 9.1.1 NOT IMPLEMENTED FUNCTIONS

Standard functions to the 80C51 that are not implemented in the 83C055:

- As Data and Program Memory are not externally expandable on the 83C055, the ALE,  $\overline{EA}$ , and PSEN signals are not implemented.
- Idle mode.
- Power-down mode.

##### 9.1.2 INTERRUPT FACILITIES DIFFERENCES

The interrupt facilities of the 83C055 differ from those of the 80C51 as follows:

##### 9.1.4 I/O PORTS DIFFERENCES

**Table 5** I/O ports differences

I/O	STANDARD 80C51	83C055
Port 0	external memory expansion	8-bit open-drain bidirectional port; and includes: alternative use for PWM outputs
Port 1	8-bit general purpose quasi-bidirectional	4-bit open-drain port, and includes alternative uses for analog inputs and a PWM output
Port 2	quasi-bidirectional and can be used for external memory expansion	open-drain and general purpose
Port 3	quasi-bidirectional; all eight bits have alternate uses	3 port bits have some of the same alternative uses as on the 80C51 but not necessarily on the same pins; 5 pins are open-drain and general purpose

- The IP register is not used, and the IE register (address A8H) is similar to that on the 80C51; see Table 36.
- The VSYNC input used by the OSD facility can generate an interrupt. The active polarity of the pulse is programmable (see Section 13.7); interrupt occurs at the leading edge of the pulse.
- Since there is no serial port, there are no interrupts nor control bits relating to this interrupt. The interrupts and their vector addresses are shown in Table 3.
- External Interrupt 1 is modified so that an interrupt is generated when the input switches are in either direction (on the 80C51, there is a programmable choice between interrupt on a negative edge or a LOW level on INT1). This facility allows for software pulse-width measurement handling of a remote control.

**Table 3** Program Memory address

EVENT	PROGRAM MEMORY ADDRESS
Reset	000H
External INT0	003H
Timer 0	00BH
External INT1	013H
Timer 1	01BH
VSync Start	023H

##### 9.1.3 PCON REGISTER DIFFERENCE

The PCON register format is shown in Table 4. Bits GF1 and GF0 are general purpose flag bits.

**Table 4** PCON Register format (address 87H)

7	6	5	4	3	2	1	0
–	–	–	–	GF1	GF0	–	–



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### 10 6-BIT PWM DACS

Figure 3 shows the 6-bit PWM DAC logic circuit, consisting of 8 PWMn modules.

The basic MCU clock is divided by 4 to get a waveform that clocks a 14-bit counter which is common to all the PWMs (including the 14-bit PWM). This divided clock is hereafter called the PWM clock.

As illustrated in Fig.3, the lower-precision (6-bit) PWMs use the least significant part of the 14-bit counter.

Figure 4 shows the circuit diagram of a 6-bit PWM module. Each PWM module has a Special Function Register PWMn; n = 0 to 7. The register format is shown in Table 6.

#### 10.1 PWM DAC operation

Value field PVn5 to PVn0 of each PWMn register (n = 0 to 7) is compared to the 6 LSBs of the common counter (14-bit counter).

When the value matches, the output flip-flop is cleared, so that the output pin is driven LOW.

When the value rolls over to zero, the output flip-flop is set, so that the output pin is released. Thus the output waveform has a fixed period of 64 PWM clock cycles; its duty cycle is determined by contents of PWMn.5 to PWMn.0 (PVn5 to PVn0).

Three of the nine total PWM modules (8 PWMn and the 14-bit PWM DAC) operate as previously described; for three others, both the rising and falling edges of the output are delayed by one PWM clock; for the remaining three, both edges are delayed by two PWM clocks. This feature reduces the radio-frequency emission that would otherwise occur when the counter rolled over to zero and all nine open-drain outputs were released.

#### 10.2 Special Function Register PWMn (n = 0 to 7)

**Table 6** Special Function Register PWMn (n = 0 to 7; addresses D4H to DFH)

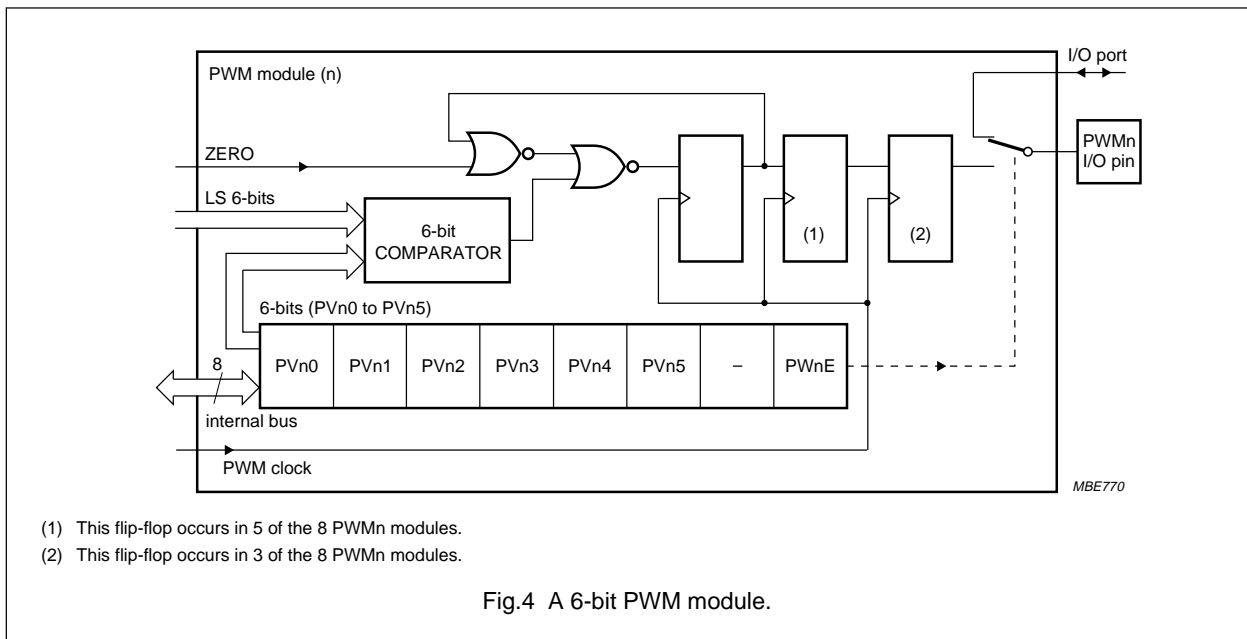
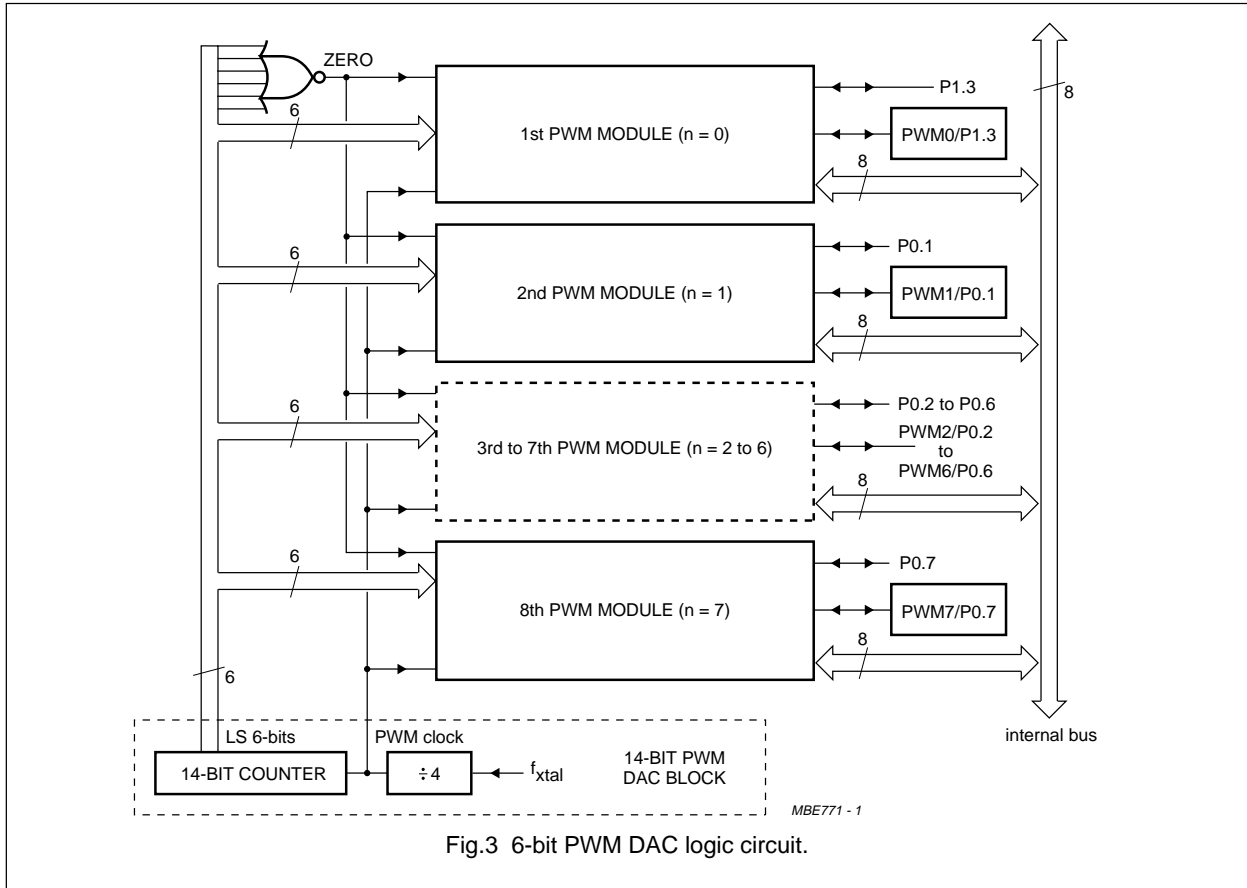
7	6	5	4	3	2	1	0
PWnE	–	PVn5	PVn4	PVn3	PVn2	PVn1	PVn0

**Table 7** Description of PWMn bits

BIT	SYMBOL	DESCRIPTION
7	PWnE	PWM module enable bit. If for a particular PWM block (n) the bit: PWnE = 1, then the block is active and controls its assigned port pin. PWnE = 0, the corresponding port pin is controlled by the port.
6	–	Reserved.
5 to 0	PVn5 to PVn0	Value field for PWMn register.

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### 11 14-BIT PWM DAC (TDAC)

#### 11.1 14-bit counter

The 14-bit counter was already mentioned in Section 10. The nature of the counter is such that it can achieve a stable output value through its MSB, and the value can propagate through logic like that shown in Fig.5. The logic output can be stable within:

- one period of the PWM clock (e.g. 250 ns) if edge-triggered logic is used to capture the logic output, or
- one phase of the PWM clock (e.g. 125 ns) if a phase of the PWM clock is used to capture the logic output.

The 14-bit (TDAC) counter is a ripple counter (cost and die-size reasons).

The 14-bit PWM DAC is controlled by two special function registers TDACL and TDACH.

#### 11.2 14-bit DAC operation

When software wishes to change the 14-bit value (TD0 to TD13), it should first write to TDACL and then write to TDACH. Alternatively, if the required precision of the duty cycle is satisfied by 6 bits or less, software can simply write to TDACH (TD8 to TD13).

##### 11.2.1 LOW PRECISION OPERATION

Figure 5 shows that this block includes an 'extra' 14-bit latch between TDACL - TDACH and the comparator and other logic. The programmed value is clocked into the operative latch when the 7 low-order bits of the counter roll over to zero, provided that the software is not in the midst of loading a new 14-bit value, i.e. it is not between writing TDACL and writing TDACH.

In a similar fashion to the lower-precision PWMs, this facility has an output flip-flop that is set when the lower 7 bits of the counter overflow/wrap. The more significant 7 bits of the operative latch's programmed value are compared for equality against the less significant 7 bits of the counter, and the output FF is cleared when they match. Thus this output has a fixed period of 128 PWM clock cycles, and the duty cycle is determined by the programmed value.

##### 11.2.2 HIGH PRECISION OPERATION

For the higher-precision aspect of this feature, the 7 MSBs of the counter are used in a logic block with the 7 LSBs of the programmed value.

The 7<sup>th</sup> LSB (binary value 64) of the programmed value is ANDed with the 7<sup>th</sup> MSB (128) of the counter, the 6<sup>th</sup> LSB of the value is ANDed with the counter's 6<sup>th</sup> and 7<sup>th</sup> MSBs being 10, and so on through the LSB of the programmed value being ANDed with the counter's 7 MSBs being 100000. Then these 7 ANDed terms are ORed. If the result is true (logic 1) at the time the 7 LSBs of the counter match the MSBs of the programmed value, the output is forced high for 1 (additional) PWM clock cycle.

The result is that, if the value-64 bit of the 14-bit value is programmed to a logic 1, every other cycle of 128 PWM counter clocks has its duty cycle stretched by one counter clock; if the value-32 bit is programmed to logic 1, every 4<sup>th</sup> cycle is stretched, and so on through, if the value-1 bit is programmed to logic 1, one cycle out of each 128 is stretched.

##### 11.2.3 14-BIT DAC OUTPUT

Assuming the external integrator can handle all this, the net effect is a PWM DAC that has the period of a 7-bit design (which makes the integrator easier and more feasible to design) with the accuracy of a 14-bit one.

An obvious prerequisite for such precision is that the load on the voltage must be very light, like a single op-amp or comparator.

##### 11.2.3.1 Note

The TDAC feature differs from the corresponding features of predecessor parts in several ways:

1. The 14-bit value is functionally composed of major and minor portions of 7 bits each.
2. The 14-bit value is programmed as a contiguous multi-register value that can be manipulated straight-forwardly via arithmetic instructions.
3. As discussed for the 6-bit DACs, both of the preceding parts had a feature whereby the PWM output could be inverted, redundantly with complementing the 14-bit value. This feature has been eliminated.

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<b>7</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>
TD7	TD0	TD1	TD2	TD3	TD4	TD5	TD6

**Table 9** Description of TDACL bits

<b>BIT</b>	<b>SYMBOL</b>	<b>DESCRIPTION</b>
7 to 0	TD7, TD0 to TD6	8 LSBs of the 14-bit value.

**11.4 Special Function Register TDACH****Table 10** Special Function Register TDACH format (address D3H)

<b>7</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>
TDE	–	TD13	TD12	TD11	TD10	TD9	TD8

**Table 11** Description of TDACH bits

<b>BIT</b>	<b>SYMBOL</b>	<b>DESCRIPTION</b>
7	TDE	Enable bit.
6	–	Reserved.
5 to 0	TD13 to TD8	6 MSBs of the 14-bit value.

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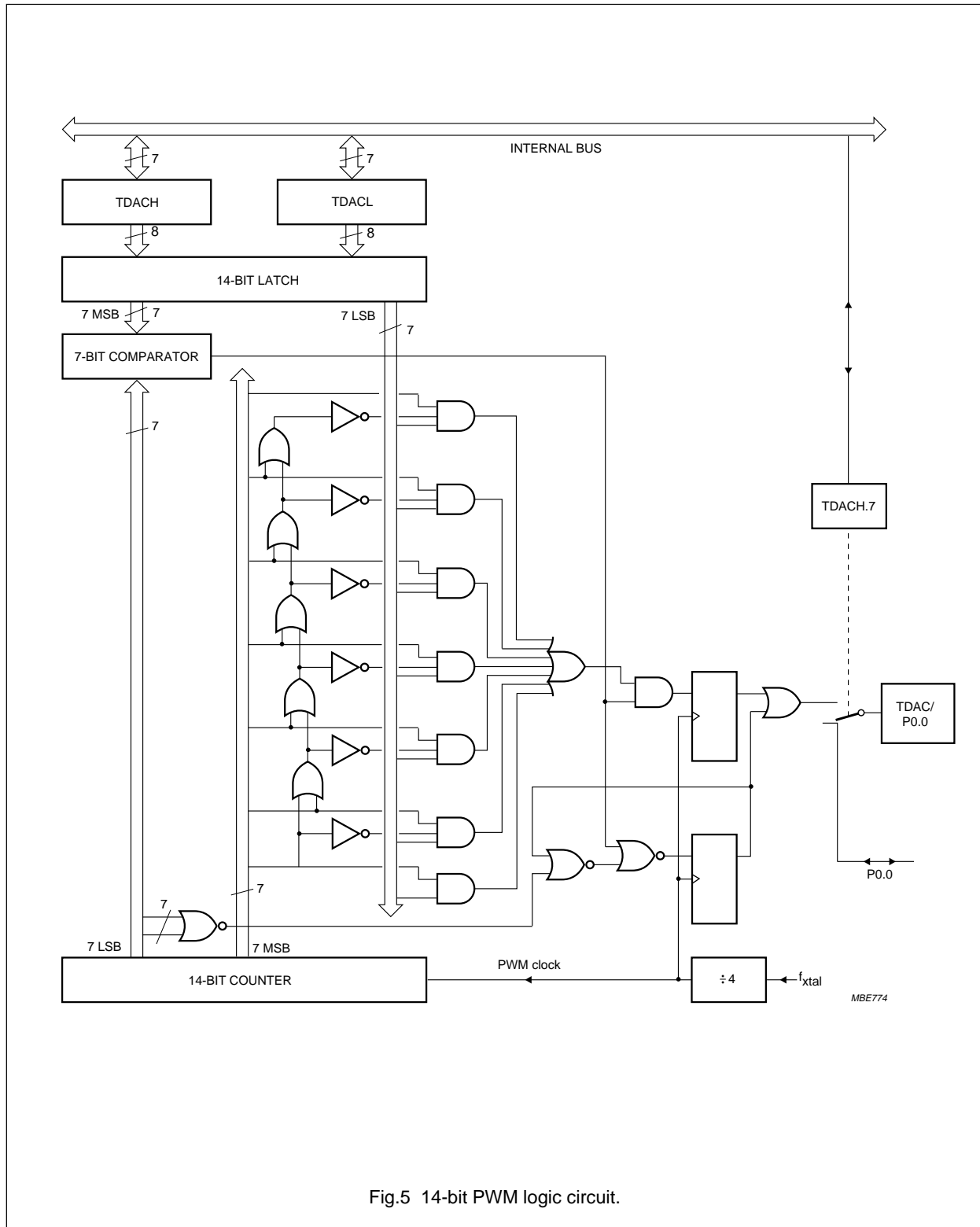


Fig.5 14-bit PWM logic circuit.

## Microcontrollers for TV and video (MTV)

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83C055; 87C055**12 SOFTWARE ANALOG-TO-DIGITAL FACILITY**

Figure 6 shows the software analog-to-digital facility block diagram. The block includes Special Function Register SAD.

**12.1 Special Function Register SAD****Table 12** Special Function Register SAD format (address D8H)

7	6	5	4	3	2	1	0
VHi	CH1	CH0	St	SAD3	SAD2	SAD1	SAD0

**Table 13** Description of SAD bits

BIT	SYMBOL	DESCRIPTION
7	VHi	The comparator output bit; bit addressable.
6	CH1	The channel field controls which pin, if any, is connected to this facility; see Table 14.
5	CH0	
4	St	The St bit should be written as a logic 1 in order to initiate a voltage comparison.
3 to 0	SAD3 to SAD0	4 LSBs of the SAD register.

**12.2 Software ADC operation**

Port pins P1.0/ADI0 to P1.2/ADI2 can be alternately selected as inputs of a linear voltage comparator. The other input of the comparator is connected to a 4-bit DAC.

This DAC is controlled by bits SAD3 to SAD0 and produces a reference voltage:

nominally 0.15625 to 4.84375 V in increments of 0.3125 V.

The output of the comparator (HIGH or LOW) can be read by the program as the MSB of the SAD register i.e. bit VHi.

After writing St = 1, the program should include intervening instructions totalling at least 6 machine cycles (72 clock periods or 6  $\mu$ s at 12 MHz), before the instruction that accesses and tests VHi.

**Table 14** Pin selection: P1.n/ADIn

CH1	CH0	P1.n/ADIn <sup>(1)</sup>
0	0	none
0	1	P1.0/ADI0
1	0	P1.1/ADI1
1	1	P1.2/ADI2

**Note**

- Port 1 has open-drain drivers which will not materially affect an analog voltage as long as any and all pins used for software analog-to-digital measurement have corresponding logic 1s in the port register; n = 0, 1, 2.

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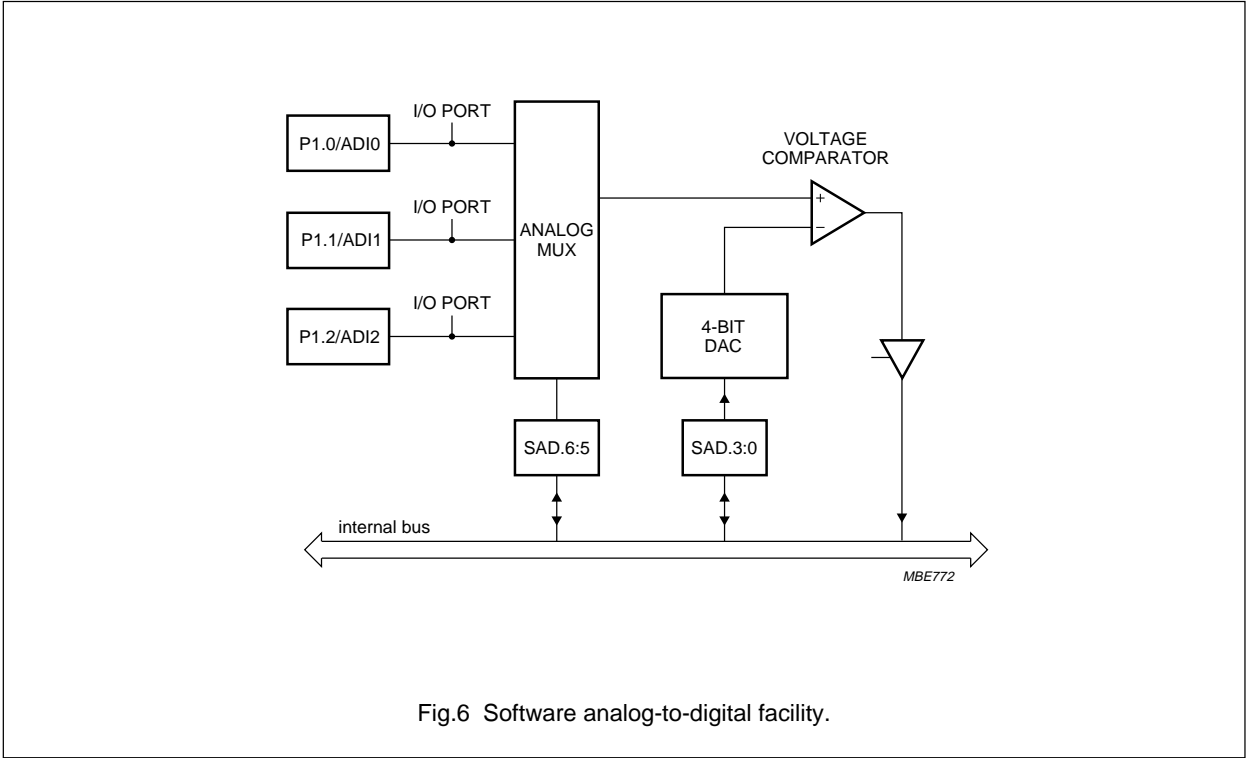


Fig.6 Software analog-to-digital facility.

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### 13 ON SCREEN DISPLAY (OSD)

Figure 7 shows the OSD block diagram. It shows the CPU writing into the  $128 \times 10$  display RAM, which is dual-ported to allow the CPU to write into it at any time, including when it is being read out by the OSD logic. The 10-bit wide data coming out of the display RAM is used to access the appropriate character in the Character Generator memory (6-bits) and to specify character and display control functions (4-bits).

Timing for the OSD is controlled by the HSYNC, VSYNC, and dot clock input VCLK1.

#### 13.1 OSD features

The 83C055 features an advanced OSD function with some unique features as described in Sections 13.1.1 to 13.1.10.

##### 13.1.1 USER-DEFINABLE DISPLAY FORMAT

The OSD does not restrict the user to a fixed number of lines with a fixed number of characters per line:

- Using a fixed number of lines restricts the generation of displays that can be differentiated from others that use the same chip and places limits on screen content.
- Using a fixed number of characters per line wastes display RAM if a line has less than the full number of displayable characters (it has to be padded with non-visible characters).

The OSD on the 83C055 defines a control character:

- New Line, that has the same function as a Carriage Return and Line Feed.

When the OSD circuitry fetches this character from display RAM it stops displaying further characters, waits for the next horizontal scan line, and starts displaying the next character in display RAM after the New Line character was received.

The number of lines is thus up to the user, within the limits of the display and memory, as are the number of characters per line. This allows far better control of the appearance of the OSD.

##### 13.1.2 COLOURS SELECTABLE BY CHARACTER

Characters can be displayed on a background of the base video or a programmable background colour. The background colour is selectable by word and the choice of background (base video/user programmed colour) by character.

##### 13.1.3 DUAL-PORTED DISPLAY RAM

The OSD has a true display RAM instead of a character line buffer. This display RAM is dual-ported to allow updating the display RAM at any time instead of having to wait for a vertical retrace.

Vertical Sync (VSYNC) interrupts are supported if flicker-free updates are required.

##### 13.1.4 PROGRAMMABLE CHARACTER SIZE

- Normal characters are displayed as  $18 \times 14$  bit maps.
- In an interlaced display:
  - 2 fields are displayed so that one actually sees a  $36 \times 14$  pixel size character.
  - The part has a double height and width mode which displays  $36 \times 28$  pixel size bit maps per field.
- For use in non-interlaced systems, the part has a double height mode so that the displayed characters have the same pixel size ( $36 \times 14$ ) as on an interlaced display.

##### 13.1.5 CHARACTER SHADOWING

When characters are displayed overlaid on a background of base video, a black border around the characters makes them highly legible. This feature is called shadowing. The 83C055 has 8 shadowing modes to allow the user to select various partial shadow modes as well as full surround shadow; see Fig.8 and Table 28.

##### 13.1.6 PROGRAMMABLE POLARITIES

Inputs to and outputs from the OSD can be programmed to be recognized as active LOW or HIGH. In conjunction with the 12 V outputs, this allows direct interfacing to most video signal processing circuits.

##### 13.1.7 CHARACTER GENERATOR MEMORY IN EPROM

On the 87C055, the Character Generator memory is in EPROM. This feature allows quick and inexpensive font development and refinement against the alternative of creating a masked ROM version to see how the final fonts will appear.

##### 13.1.8 HSYNC LOCKED DOT CLOCK OSCILLATOR

The 83C055 is designed to use an LC oscillator circuit that is started at the trailing edge of HSYNC and stopped at its leading edge. In practice, this gives a highly consistent delay from HSYNC to oscillator start and is stable from scan line to scan line so that no left margin effects are seen.



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### 13.1.9 SHORT ROWS

This mode only displays 4 horizontal lines and is used for generating underlines.

### 13.1.10 PROGRAMMABLE HORIZONTAL AND VERTICAL POSITIONS

Bit pairs HS4 to HS0 and VS2 to VS0 in register OSORG (Table 30) define the starting point of the display.

### 13.2 General description of the OSD module

This block is the largest of the additions that are specific to this product. Its basic function is to superimpose text on the television video image, to indicate various parameters and settings of the receiver or tuner. External circuitry handles the mixing (multiplexing) of the text and the TV video. The OSD block has 4 input pins:

- Two for a video clock: VCLK1 and VCLK2
- Horizontal sync signal: HSYNC
- Vertical sync signal: VSYNC.

The block has 4 outputs:

- 3 colour video signals
- a control signal.

Since this block is the major feature of the part, its main inputs and outputs are dedicated pins, without alternate port bits. The OSD of the 83C055 differs from that in preceding devices in one major way:

- It does not fix the number and size of displayed rows of text.

Several predecessor parts allowed two displayed rows of 16 characters each. The 83C055 simply has 128 locations of Display RAM, each of which can contain:

- a displayed character, or
- a New Line character that indicates the end of a row. A variant of the New Line character is used to indicate the end of displayed data.

A number of changes in the OSD architecture have reduced the number of other Special Function Registers involved in the feature, below the number needed with predecessor devices:

1. The elimination of certain options such as 4, 6, or 8 × character sizes and alternate use of two of the video outputs.
2. The moving of certain other options from central registers to Display RAM, such as foreground colour codes (Fcolor) and background (B) selection.

Figure 7 shows the 3 major elements of the OSD facility:

- OSD logic
- Display RAM
- Character Generator ROM.

### 13.3 OSD logic

For a standard NTSC TV signal with an HSYNC frequency of 15.750 kHz and a VSYNC frequency of nominally 60 Hz, there are roughly 50 μs of active horizontal scan line available.

A typical pixel clock frequency is 8 MHz, and therefore roughly 400 pixels of resolution can be obtained. At 14 dots per character, this means 28 character per horizontal scan line. If the 12 dot per character display mode is used, that means 33 character per horizontal scan line. Allowing for edge effects, 26 characters (14 across) or 31 characters (12 across) can be displayed.

Note that VGA rates and higher can be used. The minimum character dot size will be a function of the VGA frequency used. For a 640 × 480 display, running at 33 kHz, the equivalent 83C055 pixel resolution is about 160 across (because of the 8 MHz clock and allowing for overscan). This means that status and diagnostic information can be displayed on video monitors.

#### 13.3.1 ON-CHIP VIDEO OSCILLATOR

The video clock pins (VCLK1 and VCLK2) are used to connect a LC circuit to an on-chip video oscillator that is independent of the normal MCU clock.

The L and C values are chosen so that a video pulse, of a duration equal to the VCLK period, will produce a more-or-less square dot on the screen, that is, a dot having a width approximately equal to the vertical distance between consecutive scan lines.

The video oscillator is stopped (with VCLK2 = LOW) while:

- HSYNC (Horizontal Sync) is maintained, and
- is released to operate at the trailing edge of HSYNC.

This technique helps provide uniform horizontal positioning of characters/dots from one scan line to the next.

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### 13.4 Character Generator ROM

Character Generator ROM. Containing 60 displayable bit maps, i.e. 64 minus 4, comprising:

- One for each of new line: New Line, and
- Three space characters:
  - Space
  - BSpace
  - SplitBSpace.

Each bit map includes 18 scan lines by 14 dots.

The Character Generator ROM is maskable or programmable along with the Program ROM to allow for various character sets and languages.

### 13.5 Display RAM organization

Each Display RAM location includes:

- 6 data bits, and
- 4 attribute bits.

The 6 data bits from Display RAM, along with a line-within-row count, act as addresses into the Character Generator ROM. Except in special test modes that are beyond the scope of this data sheet, Display RAM cannot be read by the MCU program.

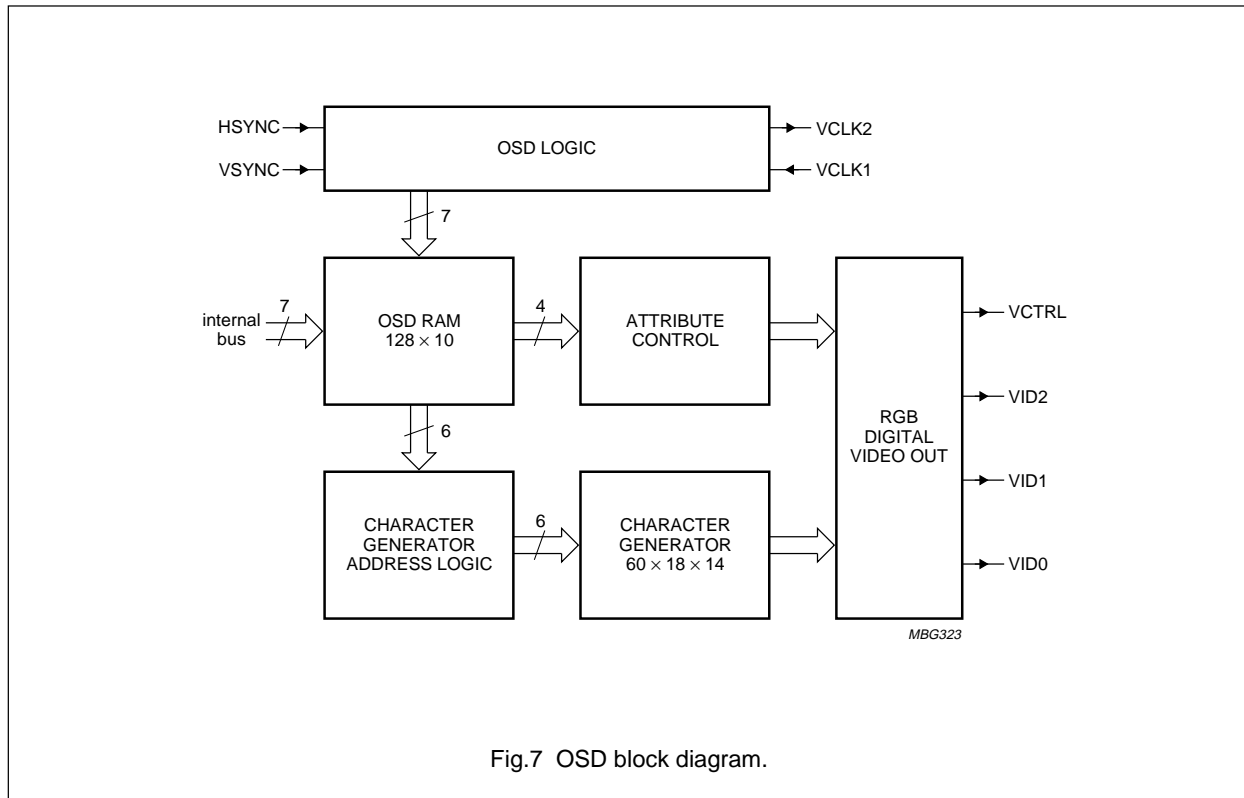


Fig.7 OSD block diagram.

## Microcontrollers for TV and video (MTV)

83C145; 83C845  
83C055; 87C055**13.6 OSD Special Function Registers**

The programming interface to Display RAM is provided by three Special Function Registers as shown in Tables 15, 17 and 20.

Writing OSAT simply latches the attribute bits into a register, while writing OSDT causes the data bus information, plus the contents of the OSAT register, to be written into display RAM.

Thus, for a given Display RAM location, OSAT should be written before OSDT. If successive characters are to be written into Display RAM with the same attributes, OSAT

need not be rewritten for each character, only prior to writing OSDT for the first character with those particular attributes.

The OSAT attribute bits associated with the BSpace, SplitBspace and New Line characters (see Table 19) are interpreted differently from those that accompany other data characters. With BSpace and SplitBspace, B is interpreted as described above, but the 3 colour bits specify the background colour (Bcolor) for subsequent characters. For BSpace, a change in B and Bcolor becomes effective at the left edge of the character's bit map.

**13.6.1 SPECIAL FUNCTION REGISTER OSAD****Table 15** Special Function Register OSAD (On Screen Address; address 9AH)

7	6	5	4	3	2	1	0
–	OSAD6	OSAD5	OSAD4	OSAD3	OSAD2	OSAD1	OSAD0

**Table 16** Description of OSAD bits

BIT	SYMBOL	DESCRIPTION
7	–	Reserved.
6 to 0	OSAD6 to OSAD0	These 7-bits hold the Display RAM address into which data will be loaded. OSAD is automatically incremented by one each time OSDT and Display RAM are written to.

**13.6.2 SPECIAL FUNCTION REGISTER OSDT**

Writing OSDT causes the data bus information, plus the contents of the OSAT register, to be written into display RAM.

**Table 17** Special Function Register OSDT (On Screen DaTa; address 99H)

7	6	5	4	3	2	1	0
–	–	OSDT5	OSDT4	OSDT3	OSDT2	OSDT1	OSDT0

**Table 18** Description of OSDT bits

BIT	SYMBOL	DESCRIPTION
7 to 6	–	Reserved.
5 to 0	OSDT5 to OSDT0	Character data; see Table 19. In reality, there is a potential conflict between the timing of a write to OSDT and an access to display RAM by the OSD logic for data display. This is resolved by the use of a true dual-ported RAM for display memory.

## Microcontrollers for TV and video (MTV)

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83C055; 87C055**Table 19** Special characters related to OSDT register

SPECIAL CHARACTER	OSDT5	OSDT4	OSDT3	OSDT2	OSDT1	OSDT0
New Line	1	1	1	1	0	1
Space (normal)	1	1	1	1	0	0
BSpace	1	1	1	1	1	0
SplitBspace	1	1	1	1	1	1

## 13.6.3 SPECIAL FUNCTION REGISTER OSAT

**Table 20** Special Function Register OSAT ( On Screen ATtributes; address 98H)

WITH OSDT =	7	6	5	4	3	2	1	0
New Line	–	–	–	E	–	SR	D	Sh
BSpace	–	–	–	B	–	BC2	BC1	BC0
SplitBspace	–	–	–	B	–	BC2	BC1	BC0
Any other character	–	–	–	B	–	FC2	FC1	FC0

**Table 21** Description of OSAT bits

BIT	SYMBOL	DESCRIPTION
7 to 5, 3	–	Reserved.
<b>With OSDT = New Line; note 1</b>		
4	E	End; If the E bit is 1, no further rows are displayed on the screen.
2	SR	Short row; If E = 0 and SR = 1, the next row is a 'short row', i.e. it is only 4 or 8 scan lines high rather than 18 or 36. Short rows can be used for underlined text.
1	D	Double height; If E = 0 and D = 1, all of the characters in the following row are displayed with 'double height and width'.
0	Sh	Shadowing; If E = 0 and Sh = 1, all of the characters in the following row are displayed with 'shadowing'; see Section 13.8.
<b>With OSDT = BSpace or SplitBspace; note 2</b>		
4	B	Background; B indicates whether 'background pixels' should show the current background colour (B = 1), or television video (B = 0).
2 to 0	BC2 to BC0	Bcolor: Background colour (notes 3 and 4; see Table 22).
<b>With OSDT = Any other character</b>		
4	B	Background; B indicates whether 'background pixels' should show the current background colour (B = 1), or television video (B = 0).
2 to 0	FC2 to FC0	Fcolor: Foreground colour. Fcolor indicates the colour of 'foreground pixels' in the ROM bit map for this character (see Table 22).

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1. The latches in which the E, SR, D, and Sh bits are captured are cleared to zero at the start of each vertical scan. This means that if the first text line on the screen is a short row, or if it contains either double size or shadowing, the text must be preceded by a New Line character. Like all such characters, this initial New Line advances the vertical screen position; the VStart value (see register OSORG; Section 13.9) should take this fact into account.
2. For SplitBSpace, a change in B and Bcolor occurs halfway through the character horizontally.
3. The normal Space character has no effect on the Bcolor value.
4. The Bcolor value is not cleared between vertical scans, so that if a single background colour is all that is needed in an application, it can be set via a single BSpace character during program initialization, and never changed thereafter. In order for such a BSpace to actually affect the 83C055 internal Bcolor register the Mode field of the OSMOD register must be set to '01B' (or higher) so that the OSD hardware is operating (see register OSMOD; Section 13.8).

**Table 22** OSD outputs related to character bit map value, Fcolor, Bcolor and B bits

CHARACTER BIT MAP VALUE	OSD OUTPUTS (notes 1 and 2)			
	VID2	VID1	VID0	VCTRL
logic 1	FC2	FC1	FC0	driven active
logic 0	BC2	BC1	BC0	B

**Notes**

1. Bcolor (BC2,BC1,BC0) values '000' and '111' minimize the occurrence of transient states among the VID2 to VID0 outputs.
2. The background colour defined by the most recently encountered BSpace or SplitBSpace character is maintained on the VID2 to VID0 pins except at the following times:
  - a) During the active time of HSYNC.
  - b) During the active time of VSYNC.
  - c) During those pixels of an active character that correspond to a logic 1 in the character's bit map.
  - d) During a 'shadow' bit.

## Microcontrollers for TV and video (MTV)

83C145; 83C845  
83C055; 87C055**13.7 OSD Control Register OSCON****Table 23** OSD Control Register OSCON (address C0H)

7	6	5	4	3	2	1	0
IV	Pv	Lv	Ph	Pc	Po	DH	BFe

**Table 24** Description of OSCON bits (see note 1)

BIT	SYMBOL	DESCRIPTION
7	IV	Interrupt flag for the OSD feature. Bit IV is set by the leading edge of the VSYNC pulse, and is cleared by the hardware when the VSYNC interrupt routine is vectored to. It can also be set or cleared by software writing a logic 1 or logic 0 to this bit.
6	Pv	Pv defines the active VSYNC input polarity. If Pv = 0, then VSYNC input is active HIGH; if Pv = 1, then VSYNC input is active LOW. One effect of bit Pv is that the VID2 to VID0 and VCTRL outputs are blocked (held at black/inactive) during the active time of VSYNC. The IV bit is set on the leading edge of the VSYNC pulse; thus Pv controls whether the OSD interrupt occurs in response to a HIGH-to-LOW or LOW-to-HIGH transition on VSYNC.
5	Lv	Lv defines the active edge of VSYNC. The active edge (leading or trailing) of VSYNC (as defined by Pv), clears the state counter which determines the vertical start of on screen data. Time reference for the video field is the leading edge of VSYNC, if Lv = 0, or the trailing edge of VSYNC, if Lv = 1.
4	Ph	Ph defines the active HSYNC input polarity. If Ph = 0, then HSYNC input is active HIGH; if Ph = 1, then HSYNC input is active LOW.
3	Pc	Pc defines the active VCTRL output polarity; VCTRL output active means: show the colour on VID2 to VID0. If Pc = 0, then VCTRL output is active HIGH; if Pc = 1, then VCTRL output is active LOW.
2	Po	Po defines the VID2 to VID0 outputs polarity; bit is needed only because the Shadowing feature needs to generate black pixels without reference to a register value. Internally, the 3-bit code '000B' always designates black. If Po = 0, a logic 0 internal to the 83C055 corresponds to a LOW on one of the VID2 to VID0 pins. If Po = 1, a logic 1 internal to the 83C055 corresponds to a LOW on one of the VID2 to VID0 pins.
1	DH	If DH = 1, character sizes are doubled vertically but not horizontally. This feature allows the 83C055 to be used in 'improved definition' systems that are not interlaced. The vertical doubling imposed by DH does not affect the VStart logic as described in Table 30; it operates in HSync units regardless of DH or D.
0	BFe	Background/Foreground enable; output BF. If BFe = 1, then the BF output tracks whether each bit in displayed characters is a Foreground bit (LOW), or a Background bit (HIGH). If BFe = 0, then the BF pin remains HIGH.

**Note**

1. It is theoretically possible that a VSYNC interrupt could be missed, or an extra one generated, if OSCON is read, then modified internally (e.g. in ACC), and the result written back to OSCON. However, none of the other bits in OSCON are reasonable candidates for dynamic change. Special provisions are included in the 83C055 logic so that IV will not be changed by a single 'read-modify-write' instruction such as SETB or CLR, unless the instruction specifically changes IV.

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83C055; 87C055**13.8 OSD Control Register OSMOD**

Under some conditions writing to OSMOD while the display is active can cause a temporary flicker during that display field. This can be avoided by only writing to OSMOD during the vertical sync interval.

**Table 25** OSD Control Register OSMOD (address C1H)

7	6	5	4	3	2	1	0
Wc	–	Mode1	Mode0	–	SHM2	SHM1	SHM0

**Table 26** Description of OSMOD bits (see note )

BIT	SYMBOL	DESCRIPTION
7	Wc	If Wc = 1, then each displayed character is horizontally terminated after 12 bits have been output, as opposed to after 14 bits if Wc = 0. This allows text to be 'packed' more tightly so that more characters can be displayed per line. In effect, the 2 bits out of the display ROM, which would otherwise be the rightmost 2 of the 14, are ignored when Wc is 1. Clearly, if this feature is to be used, it must be accounted for in the design of the bit maps in the display ROM.
6	–	Reserved.
5	Mode1	Display mode select bits; see Table 27.
4	Mode0	
3	–	Reserved.
2 to 0	SHM2 to SHM0	Shadowing mode (ShMode); determines how characters are shadowed in rows for which the row attribute Sh = 1 (register OSAT; see Table 21); for the shadowing modes see Fig.8 and Table 28.

**Table 27** Selection of Display Modes

Mode1	Mode0	DISPLAY MODE
0	0	Mode 0 The OSD feature is disabled. VCLK oscillator is disabled, VID2 to VID0 are set to black, and VCTRL is held inactive. This is the mode to which the 83C055 OSD logic is reset; note 1.
0	1	Mode 1 The VCLK oscillator is enabled and the OSD logic operates normally internally, but VID2 to VID0 are set to black and VCTRL is held inactive; note 2.
1	0	Mode 2 Normal OSD operation. Active characters can be shown against TV video (for characters with B = 0) or (for characters with B = 1) against a background of the colour defined as an attribute of BSpace and SplitBspace characters.
1	1	Mode 3 Characters can be displayed but all of the receiver's normal video is inhibited by holding VCTRL asserted throughout the active portion of each scan line; see note 3.

**Notes**

1. A direct transition from this mode to 'active display' (Mode1, Mode0 = 1X) would result in undefined operation and visual effects for the duration of the current video field (until the next VSYNC).
2. The OSD feature can be toggled between this state and 'active display' as desired to achieve real-time special effects such as 'vertical wiping'.
3. Since VID2 to VID0 are driven with the current background colour during this time, except during the foreground portion of displayed characters, this produces text against a solid background. This mode is useful for extensive displays that require user concentration.

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83C055; 87C055**Table 28** Shadowing modes determined by bits SHM2 to SHM0 (register OSMOD) and Sh (register OSAT)

SHM2	SHM1	SHM0	Sh	SHADOWING MODE <sup>(1)</sup>
0	0	0	1	South-west
0	0	1	1	West
0	1	0	1	North-west
0	1	1	1	North
1	0	0	1	North-east
1	0	1	1	East
1	1	0	1	South-east
1	1	1	1	Full surround
X	X	X	0	No Shadowing

**Note**

1. The mode names are based on the position of an apparent light source, ranging from the lower left (South-west) clockwise to the lower right (South-east); see Fig.8.

**13.9 OSD Control Register OSORG****Table 29** OSD Control Register OSORG (address C2H)

7	6	5	4	3	2	1	0
HS4	HS3	HS2	HS1	HS0	VS2	VS1	VS0

**Table 30** Description of OSORG bits (note 1)

BIT	SYMBOL	DESCRIPTION
7 to 3	HS4 to HS0	HStart field; defines the horizontal start position of all the on-screen character rows, as approximately a multiple of 4 VCLK clock cycles. Active display begins after the trailing edge of HSYNC at the position: $HP = [4 \times (HStart) + 1] \times VCLK \text{ clock cycle} + (\text{one single-sized character width})$ Where (HStart) is the decimal value of bits (HS4 to HS0); note 2.
2 to 0	VS2 to VS0	VStart field; defines the vertical start position of the first on-screen character row, as approximately a multiple of 4 HSYNC pulses. Active display begins after the field's time reference point (a range of 3 to 31) at the position: $VP = [4 \times (VStart) - 1] \times HSYNC \text{ pulses}$ Where (VStart) is the decimal value of bits (VS2 to VS0); note 3.

**Notes**

1. Neither the Hstart nor Vstart parameter is affected by the D line attribute that is used to display double-sized characters.
2. Counting variations in Wc, there may be 17 to 143 VCLK clock cycles from the end of HSYNC to the start of the first character of each row.
3. Subsequent character rows occur directly below the first, such that the last scan line of one row is directly followed by the first scan line of the next row. Successive New Line characters (with or without the Short Row designation) can be used to vertically separate text rows on the screen.



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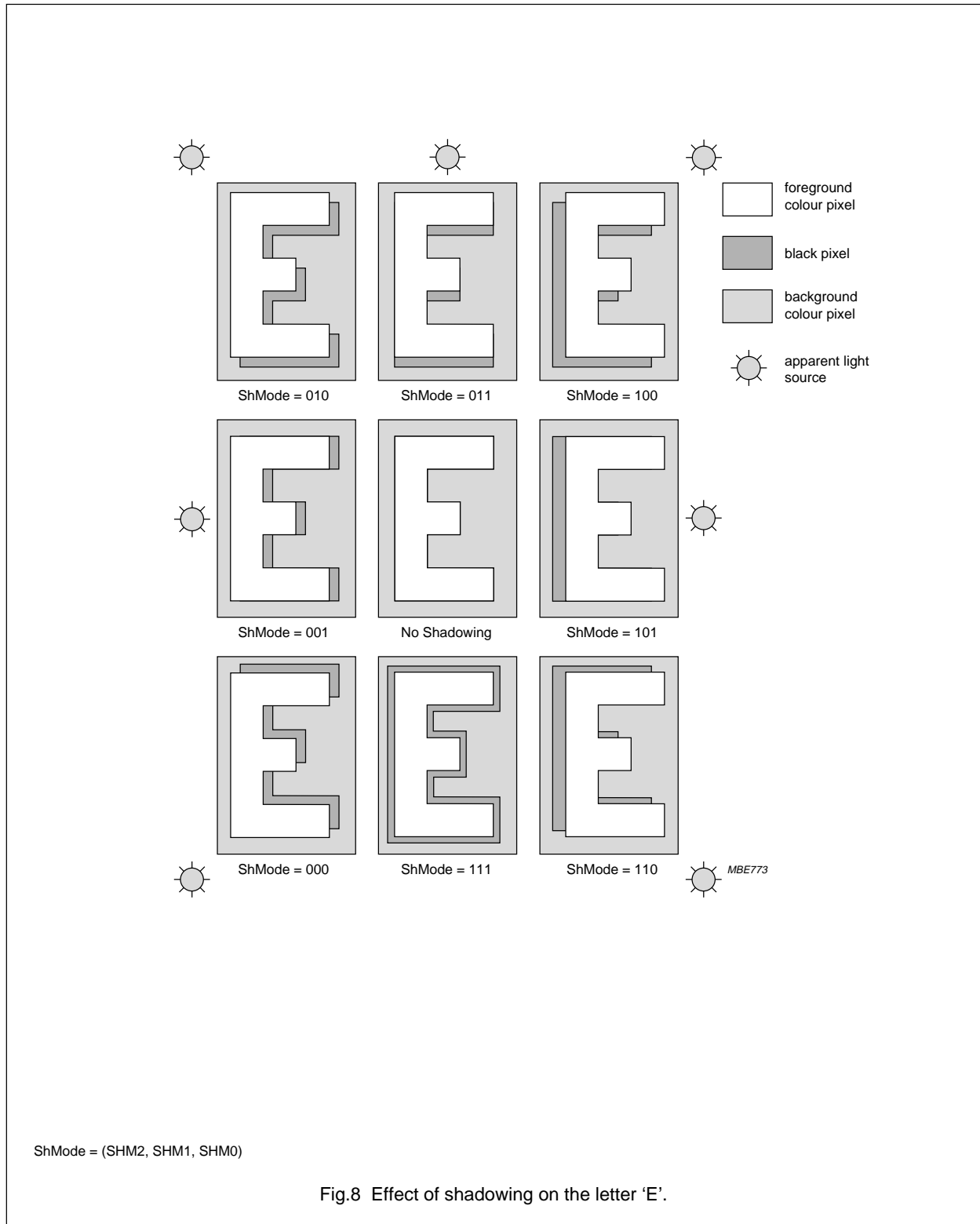


Fig.8 Effect of shadowing on the letter 'E'.

## Microcontrollers for TV and video (MTV)

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83C055; 87C055**14 PROGRAMMING CONSIDERATIONS****14.1 EPROM Characteristics**

The 87C055 is programmed by using a modified Quick-Pulse Programming algorithm similar to that used for devices such as the 87C751. It differs from these devices in that a serial data stream is used to place the 87C055 in the programming mode.

Figure 9 shows a block diagram of the programming configuration for the 87C055.

**Table 31** Pin usage for Programming

PIN	USAGE
XTAL1	Oscillator input and receives the master system clock. This clock should be between 1.2 and 6 MHz.
RESET	Used to accept the serial data stream that places the 87C055 into various programming modes. This pattern consists of a 10-bit code with the LSB sent first. Each bit is synchronized to the clock input, XTAL1.
<b>Port 0</b>	
V <sub>PP</sub> /TDAC/P0.0	Used as the programming voltage supply input (V <sub>PP</sub> signal).
PROG/PWM1/P0.1	Used as the program PROG signal. This pin is used for the 25 programming pulses.
<b>Port 2</b>	
P2.7 to P2.0	Address input for the byte to be programmed and accepts both the high- and low-order components of the 11-bit address; note 1.
<b>Port 3</b>	
P3.7 to P3.0	Used as a bidirectional data bus during programming and verify operations. During programming mode, it accepts the byte to be programmed. During verify mode, it provides the contents of the EPROM location specified by the address which has been supplied to Port 2.

**Note**

1. Multiplexing of these address components is performed using the ASEL input:
  - a) ASEL input is driven HIGH and then drive Port 2 with the high-order bits of the address. ASEL should remain HIGH for at least 13 clock cycles.
  - b) ASEL may then be driven LOW which latches the high-order bits of the address internally. The high-order address should remain on Port 2 for at least 2 clock cycles after ASEL is driven LOW.
  - c) Port 2 may then be driven with the low byte of the address. The low-order address will be internally stable 13 clock cycles later. The address will remain stable provided that the low byte placed on Port 2 is held stable and ASEL is kept LOW.
  - d) ASEL needs to be pulsed HIGH only to change the high byte of the address.

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### 14.2 Programming operation

Figures 10 and 11 show the timing diagrams for the Program/Verify cycle. Programming operation:

1. RST should initially be held HIGH for at least 2 machine cycles. P0.1 (PROG) and P0.0 ( $V_{PP}$ ) will be at  $V_{OH}$  as a result of the RST operation. At this point, these pins function as normal quasi-bidirectional I/O ports and the programming equipment may pull these lines LOW. However, prior to sending the 10-bit code on the RST pin, the programming equipment should drive these pins HIGH ( $V_{IH}$ ).
2. The RST pin may now be used as the serial data input for the data stream which places the 87C055 in the Programming Mode. Data bits are sampled during the clock HIGH time and thus should only change during the time that the clock is LOW. Following transmission of the last data bit, the RST pin should be held LOW.
3. Next the address information for the location to be programmed is placed on Port 2 and ASEL is used to perform the address multiplexing, as previously described (see Table 31; note 1).
  - a) At this time, Port 1 functions as an output.
  - b) A high voltage  $V_{PP}$  level is then applied to the  $V_{PP}$  input (P0.0). This sets Port 1 as an input port.
  - c) The data to be programmed into the EPROM array is then placed on Port 3. This is followed by a series of programming pulses applied to the PROG pin (P0.1). These pulses are created by driving P0.1 LOW and then HIGH. This pulse is repeated until a total of 25 programming pulses have occurred. At the conclusion of the last pulse, the PROG signal should remain HIGH.
4. The  $V_{PP}$  signal may now be driven to the  $V_{OH}$  level, placing the 87C055 in the Verify Mode; Port 3 is now used as an output port. After four machine cycles (48 clock periods), the contents of the addressed location in the EPROM array will appear on Port 3.
5. The next programming cycle may now be initiated by:
  - a) Placing the address information at the inputs of the multiplexed buffers.
  - b) Driving the  $V_{PP}$  pin to the  $V_{PP}$  voltage level.
  - c) Providing the byte to be programmed to Port 3 and issuing the 26 programming pulses on the PROG pin.
  - d) Bringing  $V_{PP}$  back down to the  $V_{OH}$  level and verifying the byte (see Table 33).

### 14.3 Erasure Characteristics

Erasure of the EPROM begins to occur when the chip is exposed to light with wavelengths shorter than approximately 4000 Angstroms. Since sunlight and fluorescent lighting have wavelengths in this range, exposure to these light sources over an extended time (about 1 week in sunlight, or 3 years in room level fluorescent lighting) could cause inadvertent erasure.

For this and secondary effects, it is recommended that an opaque label be placed over the window. For elevated temperature or environments where solvents are being used, apply Kapton tape Fluorless (part number 2345-5) or equivalent.

The recommended erasure procedure is exposure to ultraviolet light (at 2537 Angstroms) to an integrated dose of at least 15 Ws/cm<sup>2</sup>.

Exposing the EPROM to an ultraviolet lamp of 12000  $\mu$ W/cm<sup>2</sup> rating for 20 to 39 minutes, at a distance of about 1 inch, should be sufficient. Erasure leaves the array in an all logic 1s state.

### 14.4 Reading Signature Bytes

The Signature Bytes are read by the same procedure as a normal verify of locations 30H and 31H (the values are shown in Table 32), except that the serial code indicated in Table 33 for reading signature bytes should be used.

**Table 32** Programming and Verification codes

ADDRESS	CONTENT	INDICATION
30H	15H	manufactured by Philips
31H	4BH	87C055

**Table 33** Implementing Program/Verify Modes

OPERATION	SERIAL CODE	P0.1 (PROG)	P0.0 ( $V_{PP}$ )
Program user EPROM	286H	— <sup>(1)</sup>	$V_{PP}$
Verify user EPROM	286H	$V_{IH}$	$V_{IH}$
Read Signature Bytes	280H	$V_{IH}$	$V_{IH}$

#### Note

1. Pulsed from  $V_{IH}$  to  $V_{IL}$  and returned to  $V_{IH}$ .

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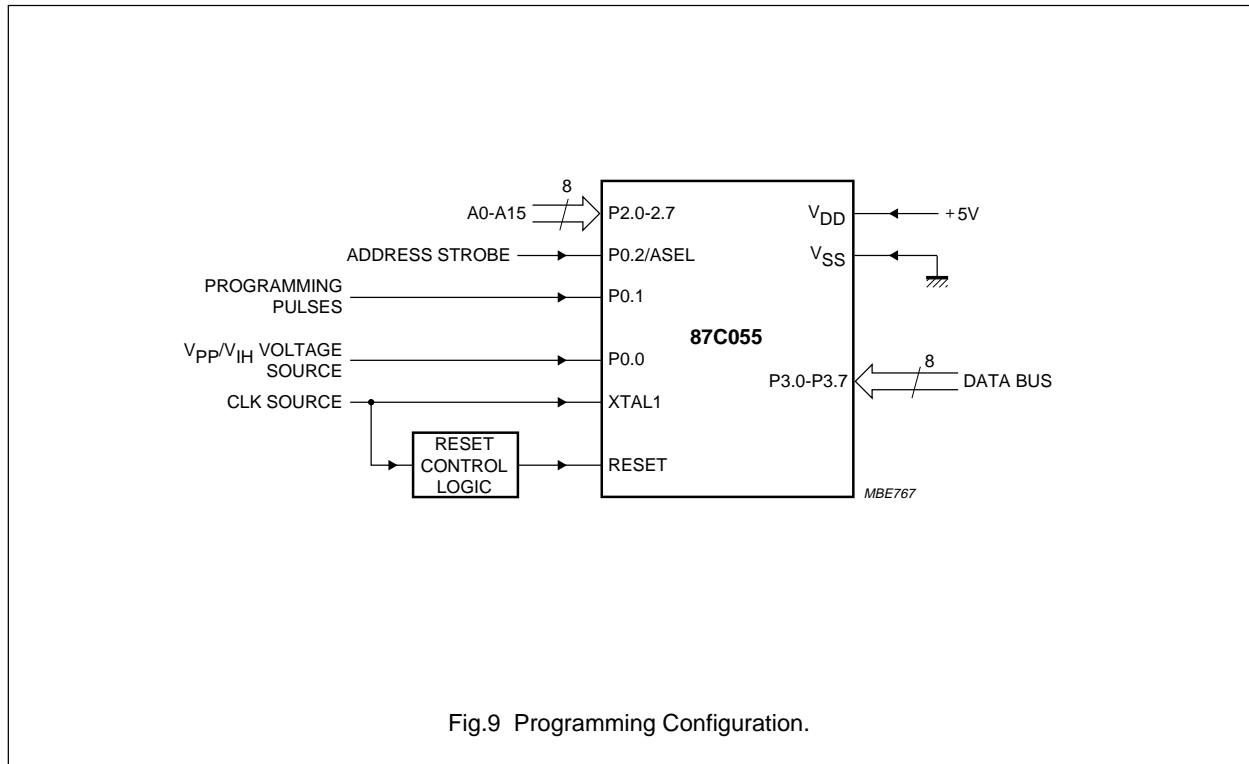


Fig.9 Programming Configuration.

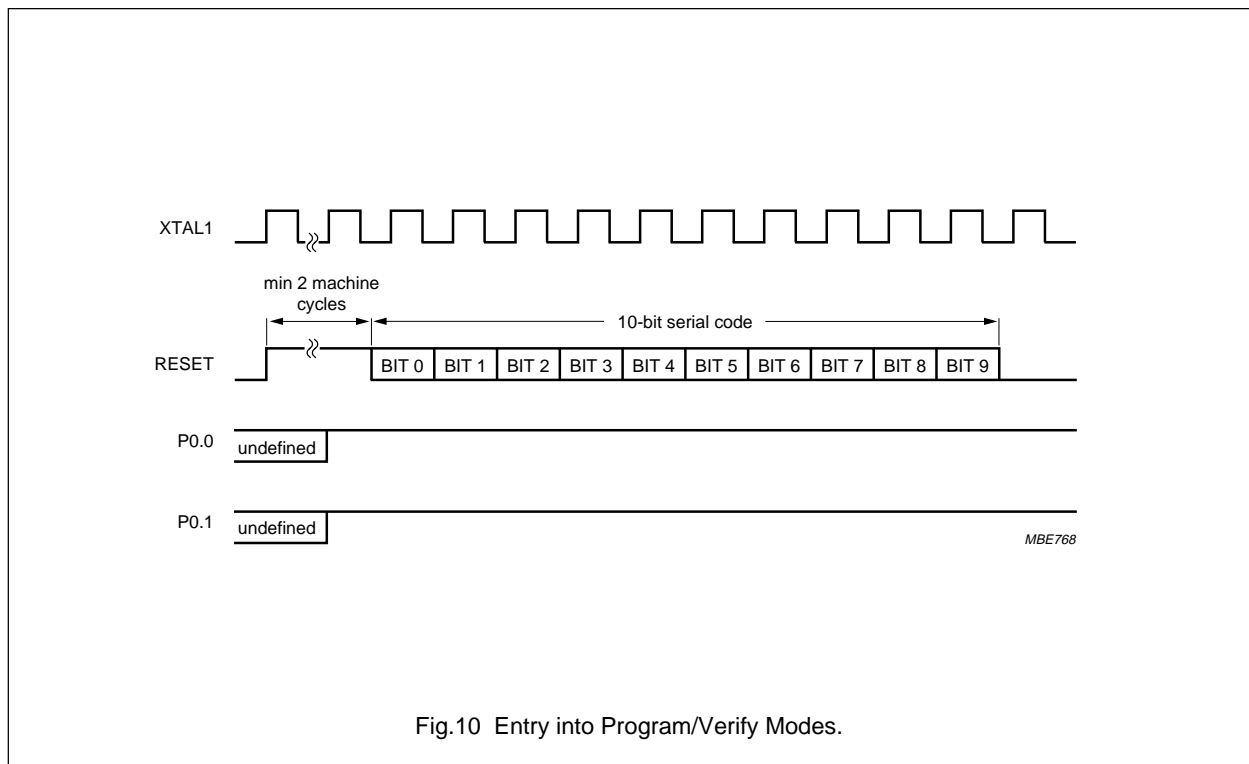


Fig.10 Entry into Program/Verify Modes.

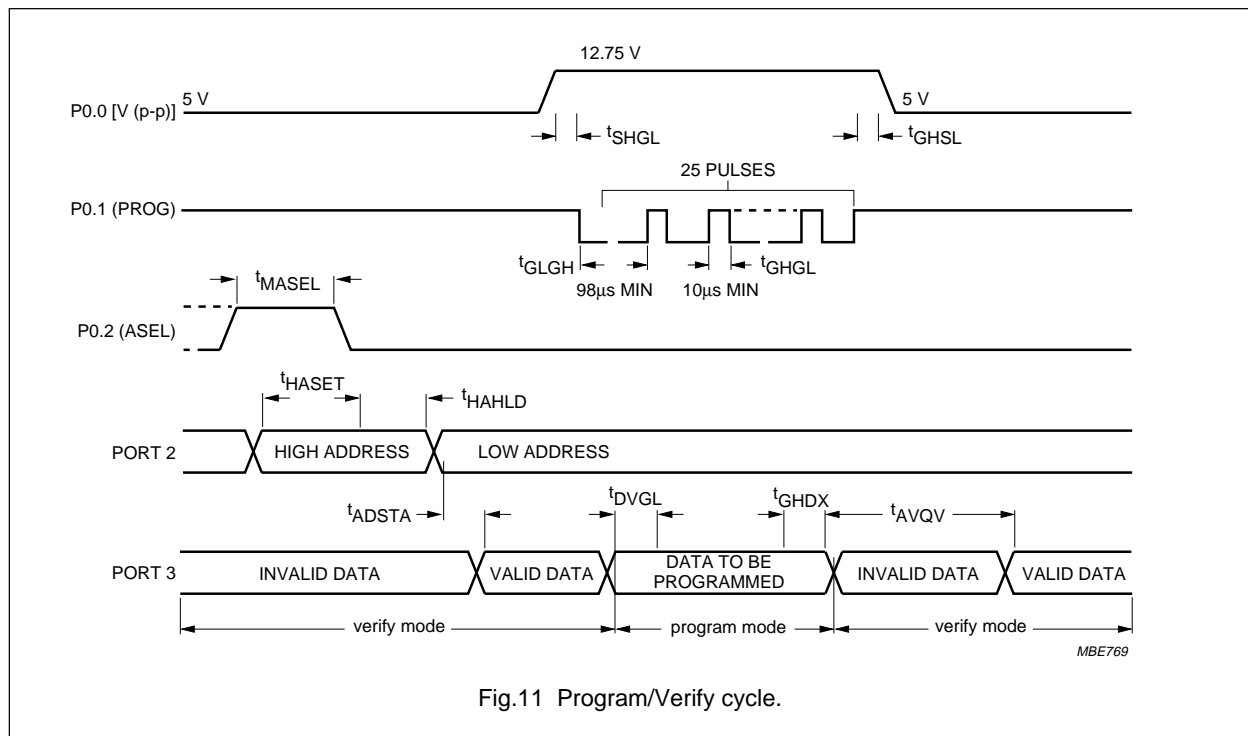
## Microcontrollers for TV and video (MTV)

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83C055; 87C055**14.5 EPROM Programming and Verification** $V_{DD} = 5\text{ V} \pm 10\%$ ;  $V_{SS} = 0\text{ V}$ ;  $T_{amb} = 21\text{ to }27\text{ }^{\circ}\text{C}$ .

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$1/t_{CLCL}$	Oscillator/clock frequency	1.2	6	MHz
$t_{AVGL}^{(1)}$	Address setup to P0.1 (PROG) LOW	$10 + 24t_{CLCL}$	–	$\mu\text{s}$
$t_{GHAX}$	Address hold after P0.1 (PROG) HIGH	$48t_{CLCL}$	–	$\mu\text{s}$
$t_{DVGL}$	Data setup to P0.1 (PROG) LOW	$38t_{CLCL}$	–	$\mu\text{s}$
$t_{GHDX}$	Data hold after P0.1 (PROG) HIGH	$36t_{CLCL}$	–	$\mu\text{s}$
$t_{SHGL}$	$V_{PP}$ setup to P0.1 (PROG) LOW	10	–	$\mu\text{s}$
$t_{GHSL}$	$V_{PP}$ hold after P0.1 (PROG) HIGH	10	–	$\mu\text{s}$
$t_{GLGH}$	P0.1 (PROG) width	90	110	$\mu\text{s}$
$t_{AVQV}^{(1)}$	$V_{PP}$ ( $V_{DD}$ ) LOW to data valid	–	$48t_{CLCL}$	$\mu\text{s}$
$t_{GHGL}$	P0.1 (PROG) HIGH to P0.1 (PROG) LOW	10	–	$\mu\text{s}$
$t_{SYNL}$	P0.0 (sync pulse) LOW	$4t_{CLCL}$	–	$\mu\text{s}$
$t_{SYNH}$	P0.0 (sync pulse) HIGH	$8t_{CLCL}$	–	$\mu\text{s}$
$t_{MASEL}$	ASEL HIGH time	$13t_{CLCL}$	–	$\mu\text{s}$
$t_{HAHLD}$	Address hold time	$2t_{CLCL}$	–	$\mu\text{s}$
$t_{HASET}$	Address setup to ASEL	$13t_{CLCL}$	–	$\mu\text{s}$
$t_{ADSTA}$	Low address to address stable	$13t_{CLCL}$	–	$\mu\text{s}$

**Note**

- Address should be valid at least  $24t_{CLCL}$  before the rising edge of P0.0 ( $V_{PP}$ ).



## Microcontrollers for TV and video (MTV)

83C145; 83C845  
83C055; 87C055

### 15 PROGRAMMING THE OSD EPROM

#### 15.1 Overview

The OSD EPROM space starts at location C000H and ends at location CFFFH. However, due to the addressing scheme of the OSD, not all locations within this space are used. The start location of the next character can be calculated by adding 40H to the start location of the previous character. For example, character 1 starts at C000H; then characters 2, 3, and 4 start at C040H, C080H, and C0C0H, respectively.

#### 15.2 Character description and programming

An example of an OSD character bit map, and the program data to obtain that character is shown in Table 34.

#### 15.3 OSD EPROM bit map

The mapping for the full OSD EPROM is shown in Table 35. To program the example character into the first character location of the OSD EPROM would require the data at the address as shown in Table 34.

Each character is 14 bits wide by 18 lines high. A character is split about a vertical axis into two sections UPPER and LOWER as illustrated in Table 34:

- Each section contains 7 bits of the character, such that:
  - the LOWER section contains bits 7 to 1, and
  - the UPPER section contains bits 14 to 8.
- The LOWER section of the character is programmed when the LSB of the program address equals a logic 0, and the UPPER section when the LSB equals a logic 1.

During Programming and Verification, each section is programmed using bytes of program data. The MSB of the program data is not used; however, the MSB location physically exists, and so will Program and Verify.

**Table 34** Example of an OSD Character Bit Map (note 1)

LINE	CHARACTER BIT MAP		PROGRAM DATA		ADDRESS (HEX)	
	UPPER (BIT 14 TO 8)	LOWER (BIT 7 TO 1)	UPPER	LOWER	UPPER	LOWER
Line 1	0000000	0000000	X0000000	X0000000	C001	C000
Line 2	0000000	0000000	X0000000	X0000000	C003	C002
Line 3	0011110	0001100	X0011110	X0001100	C005	C004
Line 4	0011110	0001100	X0011110	X0001100	C007	C006
Line 5	0011110	0001100	X0011110	X0001100	C009	C008
Line 6	0011110	0001100	X0011110	X0001100	C00B	C00A
Line 7	0011110	0001100	X0011110	X0001100	C00D	C00C
Line 8	0011110	0001100	X0011110	X0001100	C00F	C00E
Line 9	0011111	1111100	X0011111	X1111100	C011	C010
Line 10	0011111	1111100	X0011111	X1111100	C013	C012
Line 11	0011111	1111100	X0011111	X1111100	C015	C014
Line 12	0011110	0001100	X0011110	X0001100	C017	C016
Line 13	0011110	0001100	X0011110	X0001100	C019	C018
Line 14	0011110	0001100	X0011110	X0001100	C01B	C01A
Line 15	0011110	0001100	X0011110	X0001100	C01D	C01C
Line 16	0011110	0001100	X0011110	X0001100	C01F	C01E
Line 17	0000000	0000000	X0000000	X0000000	C021	C020
Line 18	0000000	0000000	X0000000	X0000000	C023	C022

#### Note

1. X can be a logic 0 or logic 1, and will Program and Verify correctly.

## Microcontrollers for TV and video (MTV)

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CHARACTER NO.	ADDRESS (HEX)		CHARACTER LINE NO.
	LOWER BYTE	UPPER BYTE	
0	C000	C001	1
	C002	C003	2
	C004	C005	3
	C006	C007	4
	C008	C009	5
	C00A	C00B	6
	C00C	C00D	7
	C00E	C00F	8
	C010	C011	9
	C012	C013	10
	C014	C015	11
	C016	C017	12
	C018	C019	13
	C01A	C01B	14
	C01C	C01D	15
	C01E	C01F	16
	C020	C021	17
	C022	C023	18
	C024 to C03F		not used
1 <sup>(1)</sup>	C040 to C063		1 to 18
	C064 to C07F		not used
2 <sup>(1)</sup>	C080 to C0A3		1 to 18
	C0A4 to C0BF		not used
3 to 59 <sup>(1)</sup>	-		-
60 <sup>(2)</sup>	CF00 to CF23		1 to 18
	CF24 to CF3F		not used
61 <sup>(2)</sup>	CF40 to CF63		1 to 18
	CF64 to CF7F		not used
62 <sup>(2)</sup>	CF80 to CFA3		1 to 18
	CFA4 to CFBF		not used
63 <sup>(2)</sup>	CFC0 to CFE3		1 to 18
	CFE4 to CFFF		not used

**Notes**

1. Characters 1 to 59 are setup in the similar way as character 0; due to space and simplicity this is not fully displayed.
2. Locations 60, 61, 62 and 63 should be programmed to logic 0s. The character names are: character no. 60 = Normal Space; character no. 61 = New Line; character no. 62 = BSpace; character no. 63 = SplitBspace.

## Microcontrollers for TV and video (MTV)

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## 16 REGISTER MAP

**Table 36** Register map

Values within parenthesis show the bit state after a reset operation; 'X' denotes an undefined state.

ADDR. (HEX)	REGISTER	7	6	5	4	3	2	1	0
E0	ACC <sup>(1)</sup>	ACC7 (0)	ACC6 (0)	ACC5 (0)	ACC4 (0)	ACC3 (0)	ACC2 (0)	ACC1 (0)	ACC0 (0)
F0	B <sup>(1)</sup>	B7 (0)	B6 (0)	B5 (0)	B4 (0)	B3 (0)	B2 (0)	B1 (0)	B0 (0)
83	DPH	DPH7 (0)	DPH6 (0)	DPH5 (0)	DPH4 (0)	DPH3 (0)	DPH2 (0)	DPH1 (0)	DPH0 (0)
82	DPL	DPL7 (0)	DPL6 (0)	DPL5 (0)	DPL4 (0)	DPL3 (0)	DPL2 (0)	DPL1 (0)	DPL0 (0)
A8	IE <sup>(1)</sup>	EA (0)	– (X)	– (0)	EVS (0)	ET1 (0)	EX1 (0)	ET0 (0)	EX0 (0)
9A	OSAD	– (X)	OSAD6 (X)	OSAD5 (X)	OSAD4 (X)	OSAD3 (X)	OSAD2 (X)	OSAD1 (X)	OSAD0 (X)
9F to 98	OSAT <sup>(1)(2)</sup>	– (X)	– (X)	– (X)	E (X)	– (X)	SR (X)	D (X)	Sh (X)
	OSAT <sup>(1)(3)</sup>	– (X)	– (X)	– (X)	B (X)	– (X)	BC2 (X)	BC1 (X)	BC0 (X)
	OSAT <sup>(1)(4)</sup>	– (X)	– (X)	– (X)	B (X)	– (X)	FC2 (X)	FC1 (X)	FC0 (X)
99	OSDT	– (X)	– (X)	OSDT5 (X)	OSDT4 (X)	OSDT3 (X)	OSDT2 (X)	OSDT1 (X)	OSDT0 (X)
C0	OSCON <sup>(1)</sup>	IV (X)	Pv (X)	Lv (X)	Ph (X)	Pc (X)	Po (X)	DH (X)	BFe (X)
C1	OSMOD	Wc (X)	– (X)	Mode1 (X)	Mode0 (X)	– (X)	SHM2 (X)	SHM1 (X)	SHM0 (X)
C2	OSORG	HS4 (X)	HS3 (X)	HS2 (X)	HS1 (X)	HS0 (X)	VS2 (X)	VS1 (X)	VS0 (X)
80	P0 <sup>(1)</sup>	P07 (1)	P06 (1)	P05 (1)	P04 (1)	P03 (1)	P02 (1)	P01 (1)	P00 (1)
90	P1 <sup>(1)</sup>	P17 (1)	P16 (1)	P15 (1)	P14 (1)	P13 (1)	P12 (1)	P11 (1)	P10 (1)
A0	P2 <sup>(1)</sup>	P27 (1)	P26 (1)	P25 (1)	P24 (1)	P23 (1)	P22 (1)	P21 (1)	P20 (1)
B0	P3 <sup>(1)</sup>	P37 (1)	P36 (1)	P35 (1)	P34 (1)	P33 (1)	P32 (1)	P31 (1)	P30 (1)
87	PCON	– (0)	– (X)	– (X)	– (X)	GF1 (X)	GF0 (X)	– (X)	– (X)
D0	PSW <sup>(1)</sup>	CY (0)	AC (0)	F0 (0)	RS1 (0)	RS0 (0)	OV (0)	– (0)	P (0)
D4	PWM0	PW0E (0)	– (0)	PV05 (0)	PV04 (0)	PV03 (0)	PV02 (0)	PV01 (0)	PV00 (0)



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ADDR. (HEX)	REGISTER	7	6	5	4	3	2	1	0
D5	PWM1	PW1E (0)	– (0)	PV15 (0)	PV14 (0)	PV13 (0)	PV12 (0)	PV11 (0)	PV10 (0)
D6	PWM2	PW2E (0)	– (0)	PV25 (0)	PV24 (0)	PV23 (0)	PV22 (0)	PV21 (0)	PV20 (0)
D7	PWM3	PW3E (0)	– (0)	PV35 (0)	PV34 (0)	PV33 (0)	PV32 (0)	PV31 (0)	PV30 (0)
DC	PWM4	PW4E (0)	– (0)	PV45 (0)	PV44 (0)	PV43 (0)	PV42 (0)	PV41 (0)	PV40 (0)
DD	PWM5	PW5E (0)	– (0)	PV55 (0)	PV54 (0)	PV53 (0)	PV52 (0)	PV51 (0)	PV50 (0)
DE	PWM6	PW6E (0)	– (0)	PV65 (0)	PV64 (0)	PV63 (0)	PV62 (0)	PV61 (0)	PV60 (0)
DF	PWM7	PW7E (0)	– (0)	PV75 (0)	PV74 (0)	PV73 (0)	PV72 (0)	PV71 (0)	PV70 (0)
D8	SAD <sup>(1)</sup>	VHi (0)	CH1 (0)	CH0 (0)	St (0)	SAD3 (0)	SAD2 (0)	SAD1 (0)	SAD0 (0)
81	SP	SP7 (0)	SP6 (0)	SP5 (0)	SP4 (0)	SP3 (0)	SP2 (0)	SP1 (0)	SP0 (0)
D3	TDACH	TDE (0)	– (0)	TD13 (0)	TD12 (0)	TD11 (0)	TD10 (0)	TD9 (0)	TD8 (0)
D2	TDACL	TD7 (0)	TD0 (0)	TD1 (0)	TD2 (0)	TD3 (0)	TD4 (0)	TD5 (0)	TD6 (0)
8F	TCON <sup>(1)</sup>	TF1 (0)	TR1 (0)	TF0 (0)	TR0 (0)	IE1 (0)	IT1 (0)	IE0 (0)	IT0 (0)
8C	TH0	TH07 (0)	TH06 (0)	TH05 (0)	TH04 (0)	TH03 (0)	TH02 (0)	TH01 (0)	TH00 (0)
8D	TH1	TH17 (0)	TH16 (0)	TH15 (0)	TH14 (0)	TH13 (0)	TH12 (0)	TH11 (0)	TH10 (0)
8A	TL0	TL07 (0)	TL06 (0)	TL05 (0)	TL04 (0)	TL03 (0)	TL02 (0)	TL01 (0)	TL00 (0)
8B	TL1	TL17 (0)	TL16 (0)	TL15 (0)	TL14 (0)	TL13 (0)	TL12 (0)	TL11 (0)	TL10 (0)
89	TMOD	GATE (0)	C/T (0)	M1 (0)	M0 (0)	GATE (0)	C/T (0)	M1 (0)	M0 (0)
C3	RAMCHR	for test purposes only							
C4	RAMATT	for test purposes only							

**Notes**

1. Bit addressable.
2. With OSDT = New Line.
3. With OSDT = BSpace or SplitBspace.
4. With OSDT = Any other character.

## Microcontrollers for TV and video (MTV)

83C145; 83C845  
83C055; 87C055**17 LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 34); see notes 1 and 2.

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$V_{DD}$	supply voltage	4.5	5.5	V
$V_I$	input voltage on any pin with respect to ground ( $V_{SS}$ )	-0.5	6.5	V
$I_{OH}$	maximum source current for all port lines	-	-1.5	mA
$I_{OL}$	maximum sink current for all port lines	-	15	mA
$P_{tot}$	total power dissipation	-	1.5	W
$T_{amb}$	operating ambient temperature	0	70	°C
$T_{stg}$	storage temperature	-65	150	°C

**Notes**

1. Stresses above those listed under Limiting Values may cause permanent damage to the device.
2. Parameters are valid over operating temperature range unless otherwise specified. All voltages are with respect to  $V_{SS}$  unless otherwise noted.

**18 HANDLING**

Inputs and outputs are protected against electrostatic discharge in normal handling. However it is good practice to take normal precautions appropriate to handling MOS devices (see "*Handling MOS devices*").

## Microcontrollers for TV and video (MTV)

83C145; 83C845  
83C055; 87C055**19 DC CHARACTERISTICS** $V_{DD} = 5\text{ V} \pm 10\%$   $T_{amb} = 0\text{ to }+70\text{ }^{\circ}\text{C}$ ; all voltages with respect to  $V_{SS}$ ; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supply</b>						
$V_{DD}$	operating supply voltage		4.5	5.0	5.5	V
$I_{DD}$	operating supply current	$V_{DD} = 5.5\text{ V}$ ; note 1	–	–	30	mA
$V_{IL}$	LOW level input voltage		–0.5	–	$0.2V_{DD} - 0.1$	V
$V_{IL1}$	LOW level input voltage; VSYNC and HSYNC		–0.5	–	$0.15V_{DD}$	V
$V_{IH}$	HIGH level input voltage; XTAL, VCLK1 and RST		$0.7V_{DD}$	–	$V_{DD} + 0.5$	V
$V_{IH1}$	HIGH level input voltage; P1.2 to P1.0, P3.6 to P3.5 and P3.3 to P3.1		$0.2V_{DD} + 0.9$	–	$V_{DD} + 0.5$	V
$V_{IH2}$	HIGH level input voltage; P1.3, P3.7, P3.4 and P3.0		$0.2V_{DD} + 0.9$	–	12.6	V
$V_{IH3}$	HIGH level input voltage; VSYNC and HSYNC		$0.67V_{DD}$	–	$V_{DD} + 0.5$	V
$V_{IH} - V_{DD}$	HIGH level input voltage with respect to $V_{DD}$ ; Port 0, P1.3, P3.7, P3.4 and P3.0	note 2	$0.7V_{DD}$	–	$V_{DD} + 0.5$	V
$V_{OL1}$	LOW level output voltage; P2.7 to P2.0 and P3.6 to P3.5	$I_{OL} = 10\text{ mA}$ ; note 3	–	–	0.5	V
$V_{OL2}$	LOW level output voltage; TDAC and PWM0 to PWM7	$I_{OL} = 700\text{ }\mu\text{A}$ ; note 4	–	–	0.5	V
$V_{OL3}$	LOW level output voltage; all other outputs	$I_{OL} = 1.6\text{ mA}$	–	–	0.45	V
$V_{OH}$	HIGH level output voltage; Port 1, VID2 to VID0, VCTRL and BF	$I_{OH} = -60\text{ }\mu\text{A}$	2.4	–	–	V
$R_{RST}$	Reset (RST) pull-down resistor		50	–	300	k $\Omega$
$C_{IO}$	Pin capacitance; except P0.0 and P0.7	test freq. = 1 MHz; $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; note 5	–	–	10	pF
HYS	Hysteresis; VSYNC and HSYNC		0.8	–	–	V

**Notes**

- $I_{DD}$  measured with OSD block initialized and RST remaining LOW.
- This maximum applies at all times, including during power switching, and must be accounted for in power supply design. During a Power-on process, the +12 V source used for external pull-up resistors should not precede the  $V_{DD}$  of the 83C055 up their respective voltage ramps by more than this margin, nor, during a Power-down process, should  $V_{DD}$  precede +12 V down their respective voltage ramps by more than this margin.
- No more than 6 (any 6) of these 10 high current outputs may be used at the  $V_{OL1}$  ( $I_{OL} = 10\text{ mA}$ ) specification. The other 4 should comply with the  $V_{OL3}$  specification ( $I_{OL} = 1.6\text{ mA}$ ).
- The specified current rating applies when any of these pins is used as a Pulse Width Modulated (PWM) output. For use as a port output, the rating is as given subsequently.
- The capacitance of pins P0.0 and P0.7 for the 87C055 exceeds 10 pF; for P0.0 this is maximum 40 pF, while for P0.7 it is maximum 20 pF.

## Microcontrollers for TV and video (MTV)

83C145; 83C845  
83C055; 87C055**20 AC CHARACTERISTICS** $V_{DD} = 5\text{ V} \pm 10\%$ ;  $T_{amb} = 0\text{ to }+70\text{ }^{\circ}\text{C}$ ; all voltages with respect to  $V_{SS}$ ; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$1/t_{CLCL}$	XTAL frequency	note 1	6	–	12	MHz
$t_{CHCX}$	XTAL1 clock HIGH time	note 2	20	–	–	ns
$t_{CLCX}$	XTAL1 clock LOW time		20	–	–	ns
$t_{CLCH}$	XTAL1 clock rise time		–	–	20	ns
$t_{CHCL}$	XTAL1 clock fall time		5	–	20	ns
$1/t_{VCLCL}$	VCLK frequency		5	–	8	MHz
$ t_{VCOH} - t_{VCOL} $	Rise versus fall time skew on any one of VID2 to VID0, VCTRL and BF	note 3	–	–	40	ns
$ t_{VCOH1} - t_{VCOH2} $	Rise time skew between any two of VID2 to VID0, VCTRL and BF		–	–	30	ns
$ t_{VCOL1} - t_{VCOL2} $	Fall time skew between any two of VID2 to VID0, VCTRL and BF		–	–	30	ns

**Notes**

1. The 83C055 is tested at its maximum XTAL frequency, but not at any other (lower) rate.
2. These parameters apply only when an external clock signal is used.
3. These parameters assume equal loading at  $C_L = 100\text{ pF}$ , for all the referenced outputs. These parameters are specified but not tested.

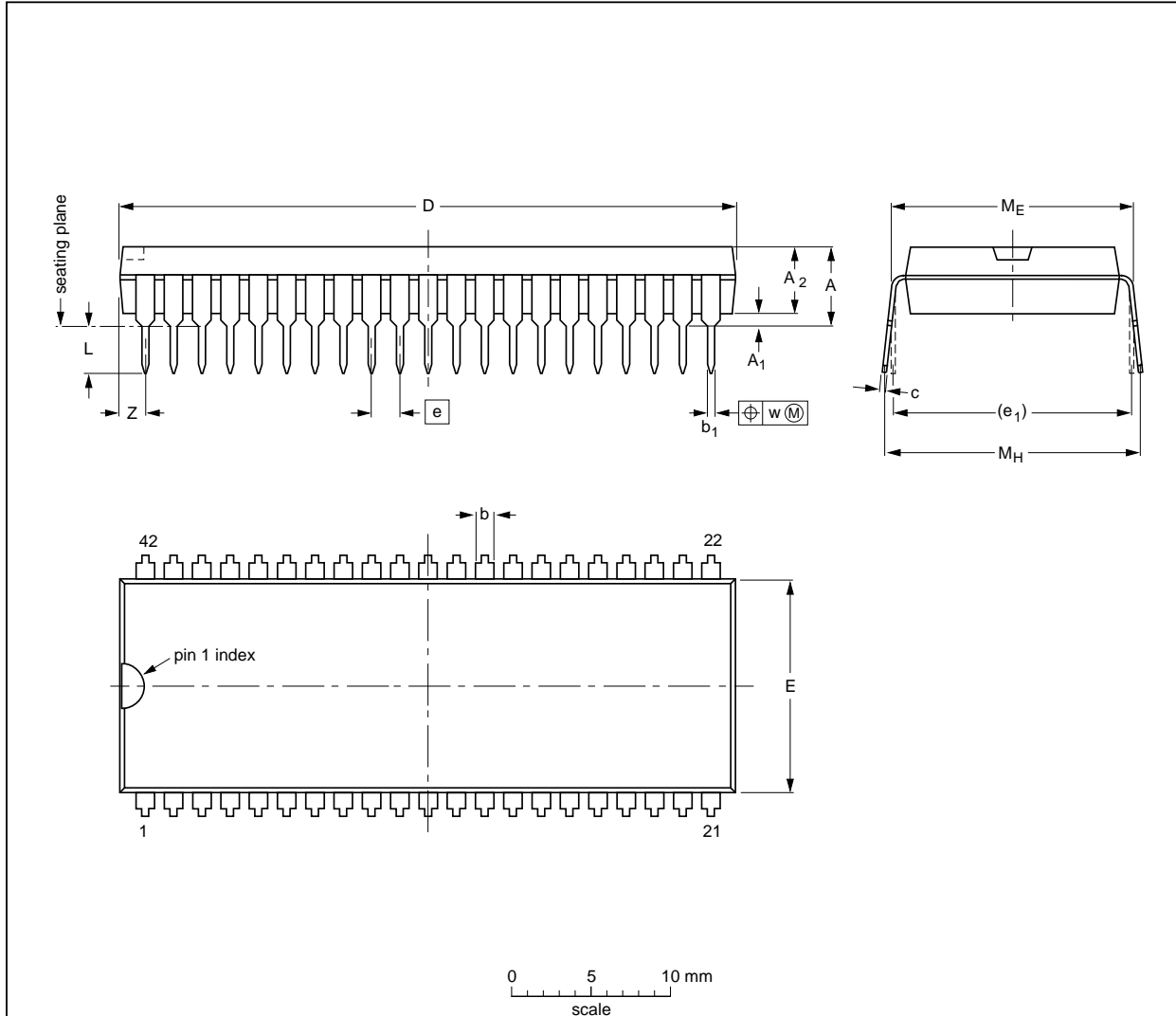
Microcontrollers for TV and video (MTV)

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21 PACKAGE OUTLINES

SDIP42: plastic shrink dual in-line package; 42 leads (600 mil)

SOT270-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	L	M <sub>E</sub>	M <sub>H</sub>	w	Z <sup>(1)</sup> max.
mm	5.08	0.51	4.0	1.3 0.8	0.53 0.40	0.32 0.23	38.9 38.4	14.0 13.7	1.778	15.24	3.2 2.9	15.80 15.24	17.15 15.90	0.18	1.73

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT270-1						90-02-13 95-02-04

## Microcontrollers for TV and video (MTV)

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## 22 SOLDERING

### 22.1 Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these cases reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

### 22.2 Soldering by dip or wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted to the seating plane, but the temperature of the plastic body must not exceed the specified storage maximum. If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

### 22.3 Repairing soldered joints

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

## 23 DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

## 24 LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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**NOTES**

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