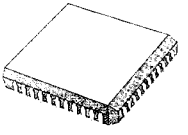
8 BIT HCMOS MCUs WITH A/D CONVERTER & LCD DRIVER

PRELIMINARY DATA

- 8-BIT ARCHITECTURE
- STATIC HCMOS OPERATION
- 3.0 TO 6.0 V SUPPLY OPERATING RANGE
- 3.25US TCYCLE (with 4 MHz clock)
- RUN, WAIT & STOP MODES
- USER ROM : 3876 BYTES
- RESERVED ROM : 220 BYTES
- DATA ROM : 64 BYTES
- DATA RAM : 64 BYTES
- 44-PIN PLASTIC PLCC PACKAGE (ST6040)
- 48-PIN PLASTIC DUAL IN LINE PACKAGE (ST6041)
- 15 PUSH-PULL BIDIRECTIONAL INPUTS/OUTPUTS WITH 5mA DRIVING CAPABILITY (ST6040)
- 16 PUSH-PULL BIDIRECTIONAL INPUTS/OUTPUTS WITH 5mA DRIVING CAPABILITY (ST6041)
- TWO 8-BIT COUNTER WITH A 7-BIT PROGRAMMABLE PRESCALER (Timer)
- DIGITAL SOFTWARE ACTIVATED WATCHDOG/TIMER (DSWD)
- 8-BIT A/D CONVERTER WITH 3 ANALOG INPUTS
- 18 LINES LCD DRIVER WITH 2:1 MULTIPLEXING (36 segments driving, ST6040)
- 20 LINES LCD DRIVER WITH 2:1 MULTIPLEXING (40 segments driving, ST6041)
- ONE EXTERNAL RISING EDGE SENSITIVE INTERRUPT INPUT (ST6040)
- ONE EXTERNAL FALLING EDGE SENSITIVE INTERRUPT INPUT (ST6041)
- ON-CHIP CLOCK OSCILLATOR
- POWER-ON RESET
- BYTE EFFICIENT INSTRUCTION SET
- BIT TEST AND JUMP INSTRUCTIONS
- WAIT, STOP AND BIT MANIPULATION INSTRUCTIONS
- TRUE LIFO 4 LEVEL STACK
- 9 POWERFUL ADDRESSING MODES
- THE ACCUMULATOR, THE X, Y, V & W REGISTERS, THE PORT AND PERIPHERALS DATA/CONTROL REGISTERS ARE ADDRESSED IN THE DATA SPACE AS RAM LOCATIONS
- THE DEVELOPMENT TOOL OF THE ST604X MICROCONTROLLERS CONSISTS OF THE EMS6-HW/B4X EMULATION AND DEVELOPMENT SYSTEM CONNECTED VIA A STANDARD RS232 SERIAL LINE TO AN MS-DOS PC
- ST60R4X IS THE ROMLESS VERSION



PLCC44

DIP-48

(Order Codes at the end of the datasheet)

Figure 1 : ST6040 Pin Configuration.

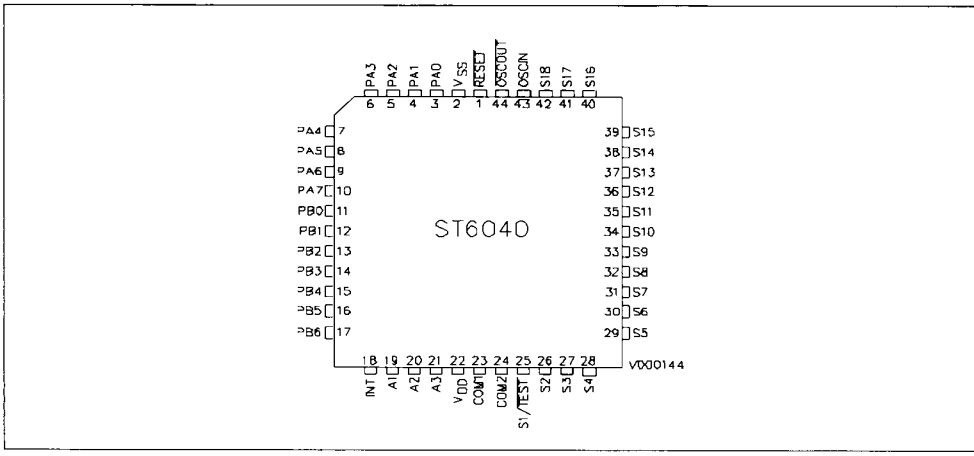
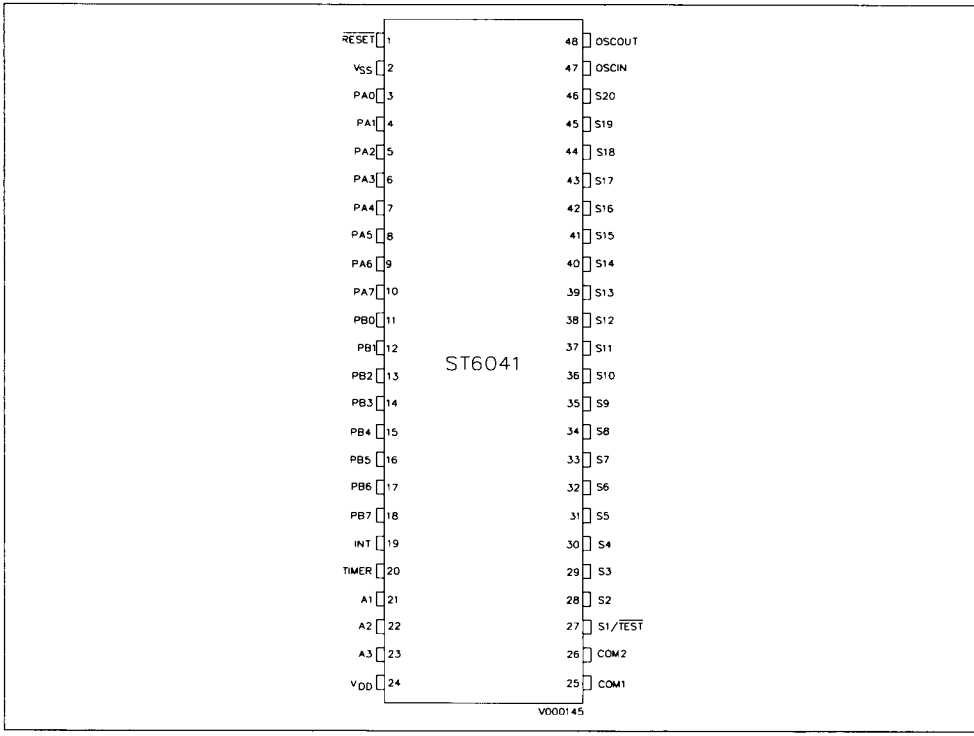


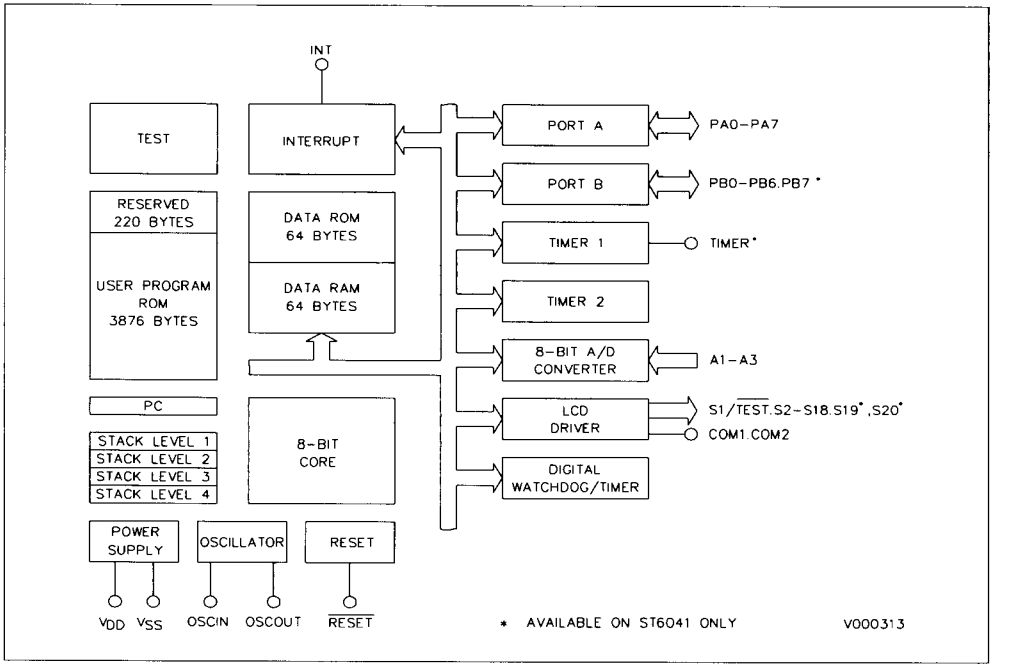
Figure 2 : ST6041 Pin Configuration.



GENERAL DESCRIPTION

The ST6040 and ST6041 microcontrollers are powerful members of the 8-bit HCMOS ST60XX family, a series of devices oriented to low-medium complexity applications. All ST60XX members are based on a building block approach : to a common core is associated a combination of on-chip peripherals (macrocells) available from a standard library to form around the core all the existing and future ST6 devices.These peripherals are designed with the same core technology giving full compatibility, short design and testing time. The macrocells of the ST6040/ST6041 are : two Timers each including an 8-bit counter with a 7-bit software programmable prescaler (Timer), the 8-bit A/D Converter with 3 analog inputs, the liquid crystal display driver (LCD) with 18x2 (ST6040) and 20x2 (ST6041) lines (36/40 segments), the software activated digital watchdog/timer (DSWD). Thanks to these peripherals the ST6040/ST6041 are well suited to consumer, automotive and industrial controls applications.

Figure 3 : ST6040 and ST6041 Block Diagram.



PIN DESCRIPTION

V_{DD} and V_{SS}. Power is supplied to the MCU using these two pins. V_{DD} is power and V_{SS} is the ground connection.

OSCIN, OSCOUT. These pins are internally connected with the on-chip oscillator circuit. A crystal quartz or a ceramic resonator has to be connected between these two pins in order to allow a right operating of the MCU. The OSCIN pin is the input pin, the OSCOUT pin is the output pin.

$\overline{\text{RESET}}$. The active low RESET pin is used to restart the microcontroller at the beginning of its program.

INT. The INT pin provides the capability for asynchronous applying an external interrupt to the MCU.This pin is rising edge sensitive on ST6040 and falling edge sensitive on ST6041.

PA0-PA7. These 8 lines are organized as one I/O port (A). Each line may be configured as either an input or an output under software control of the data direction register. Port A has a push-pull output configuration with 5mA drive capability and schmitt trigger inputs.

PB0-PB6,PB7 (*). These 8 lines are organized as one I/O port (B). Each line may be configured as either an input or an output under software control of the data direction register. Port B has a push-pull output configuration with 5mA drive capability and schmitt trigger inputs. (*) PB7 is available only on ST6041.

TIMER (*). This is the Timer 1 I/O pin. In input mode it is connected to the prescaler and acts as external timer clock (DOUT=TOUT=0) or as control gate for the internal timer clock (DOUT=1,TOUT=0). In the output mode the timer pin outputs the data bit when a time out occurs. (*) This pin is available only on ST6041.

A1-A3. These pins are the analog inputs for the on-chip 8-bit A/D converter. The user can select by software which analog channel has to be converted.

COM1, COM2. These two pins are the LCD peripheral common outputs. They are the outputs of the on-chip backplane voltage generator which is used for multiplexing the 18/20 LCD lines allowing 36/40 segments driving.

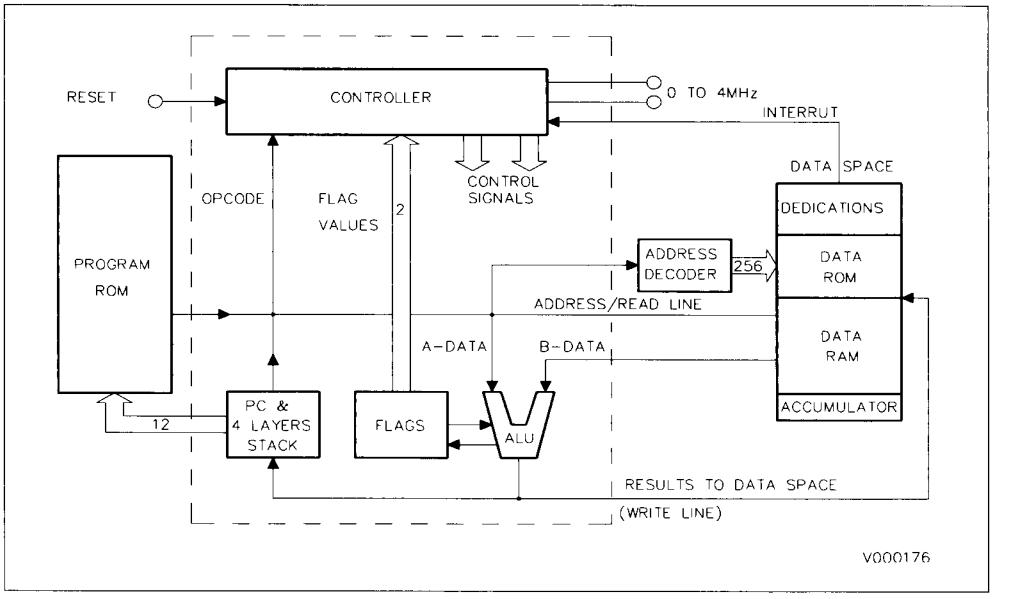
S1/**$\overline{\text{TEST}}$**. This pin is the LCD driver segment 1 output but also enables the factory test mode if tied low when Reset is active. The test mode is used to place the MCU into special operating mode.

S2-S18,S19(*),S20(*). These pins are the LCD driver segments outputs 2 to 20. (*) S19 and S20 are available only on ST6041.

ST60XX CORE

The Core of the ST60XX Family is implemented independently from the I/O or memory configuration. Consequently, it can be treated as an independent central processor communicating with I/O and memory via internal addresses, data, and control buses. The in-core communications are arranged as shown in the following block diagram figure; the controller being externally linked to both the reset and the oscillator while the core is linked to the dedicated on-chip macrocells peripherals via the serial data bus and indirectly for interrupt purposes, through the control registers.

Figure 4 : ST60XX Core Block Diagram.



INPUT/OUTPUT PORT

The ST6040 and ST6041 microcontrollers have respectively 15 and 16 Input/Output lines that can be individually programmed either in the input mode or the output mode. The lines are organized in two ports (port A,B). The ports occupies four registers in the data space there being two registers, the DATA registers (DRA, DRB), used to read the logic level values of the lines programmed in the input mode or to write the logic value of the signal to be output on the lines configured in the output mode, and two DATA DIRECTION registers (DDRA, DDRB), that allow the selection of the direction of each pin (input or output). In input mode the data register remains unchanged as the logic value at port pins is read directly into the shift register of the port macrocell.

TIMERS

The ST6040 and ST6041 offer two on-chip Timer peripherals each consisting of an 8-bit counter with a 7-bit programmable prescaler, thus giving a maximum count of 2^{15}, and a control logic that allows configuring the peripheral in three operating modes. Timer 1 of ST6041 has the external TIMER pin available for the user. The content of the 8-bit counter can be read/written in the Timer/Counter register TCR that can be addressed in the data space as RAM location at the 13H (timer 1) and 16H (timer 2) addresses. The state of the 7-bit prescaler can be read in the PSC register at the 12H (timer 1) and 15H (timer 2) addresses. The control logic device can be managed thanks to the TSCR register (14H timer 1 and 17H timer2 addresses).

SOFTWARE ACTIVATED DIGITAL WATCHDOG/TIMER

The software activated digital watchdog/timer consists of a down counter that can be used to provide a controlled recovery from a software upset or as a simple 7-bit timer for general purpose counting. The watchdog/timer is using one data space register (DSWDR location 18H). The watchdog register is set to FEH after reset and the watchdog function is disabled. If the user is using the cell as a watchdog the watchdog time can be programmed using the 6 MSBits in the Watchdog/timer register; if the user selects the timer option there are 7 available counter bits. This is because when the cell is used as watchdog function bit 1 of the register is used for managing the watchdog. The check time can be set differently for different routines within the general program.

8-BIT A/D CONVERTER

The ST6040 and ST6041 A/D converter is an 8-bit analog to digital converter with 3 analog inputs offering 8-bit resolution with $\pm$ 1/2 bit of linearity and a conversion time of 150uS (clock frequency of 4MHz). The ST6040 and ST6041 A/D peripheral converts by a process of successive approximations using a clock frequency from 100 to 500Khz. The clock is derived from the oscillator with a division factor of twelve.

LIQUID CRYSTAL DISPLAY DRIVER LCD

The Liquid Crystal Display Driver macrocell is based on an eight segment driver which can be multiplexed by the use of two backplanes. The ST6040 and ST6041 LCD allows two-lines multiplexed operation of 18 and 20 segments pair allowing direct driving of 36/40 segments.

DEVELOPMENT SUPPORT & EMULATION SYSTEM

The ST60XX development system offers powerful in-circuit emulator and easy-to-use sets (dedicated boards) of modular hardware and software tools to shorten the total system development time of the final application. The ST60XX emulator offers emulation power with plug-in flexibility in the selection of emulation hardware modules for the dedicated macrocells. The emulator can be interfaced with a standard RS232 serial link to industry standard MS-DOS personal computers. The ST60R4X romless version is also available to provide flexibility in prototypes or pre-production.

ABSOLUTE MAXIMUM RATINGS

This product contains devices to protect the inputs against damage due to high static voltages, however it is advised to take normal precaution to avoid application of any voltage higher than maximum rated voltages. For proper operation it is recommended that V_I and V_O must be higher than V_{SS} and smaller than V_{DD}. Reliability is enhanced if unused inputs are connected to an appropriated logic voltage level (V_{DD} or V_{SS}).

Symbol	Parameter	Value	Unit
V_{DD}	Supply Voltage	– 0.3 to 7.0	V
V_I	Input Voltage	V_{SS} – 0.3 to V_{DD} + 0.3	V
V_O	Output Voltage	V_{SS} – 0.3 to V_{DD} + 0.3	V
I_O	Current Drain per Pin Excluding V_{DD} & V_{SS}	± 10	mA
IV_{DD}	Total Current into V_{DD} (source)	50	mA
IV_{SS}	Total Current out of V_{SS} (sink)	50	mA
PD	Power Dissipation	30	mW
ESD	ESD Susceptibility	2000(1)	V
T_{stg}	Storage Temperature	– 65 to 150	°C

Notes : 1. MIL 883B Mode, 100pF through 1.5KΩ.
2. Stresses above those listed as "absolute maximum ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
T_A	Operating Temperature	6 Version 7 Version	– 40 – 40		85 110	°C °C
V_{DD}	Operating Supply Voltage		3		6	V
f_{OSC}	Oscillator Frequency	V_{DD} = 4.5 – 6.0V	0		4	MHz
f_{OSC}	Oscillator Frequency	V_{DD} = 3.5V	0		1	MHz
f_{OSC}	Oscillator Frequency	V_{DD} = 3.0V	0		0.5	MHz
AV_{DD} AV_{SS}	Analog Supply Voltage		V_{SS}		V_{DD}	V

Note : On ST6040/ST6041 AV_{DD} and AV_{SS} are internally connected to digital V_{SS} and V_{DD}.

THERMAL CHARACTERISTICS

$R_{th(J-A)}$	Thermal Resistance P-DIP PLCC	Max.	65 85	°C/W

POWER CONSIDERATIONS

The average chip-junction temperature, Tj, in Celsius can be obtained from :

$$Tj = TA + PD \times RthJA$$

where : TA = Ambient Temperature,

RthJA = Package thermal resistance (junction-to-ambient,

PD = Pint + Pport,

Pint = $I_{DD} \times V_{DD}$ (chip internal power),

Pport = Port power dissipation (determined by the user).

For most applications, Pport < Pint and the former can be neglected. Pport may become significant if the device is configured to drive darlington bases or sink LED loads. An approximate relationship between PD and TJ (if Pport is neglected) is :

$$PD = K (TJ + 273).$$

Solving previous equations gives:

$$K = PD \times (TA + 273) + RthJA \times PD^2$$

where K is constant pertaining to the particular part. K can be determined from the equation by measuring PD for a know TA. Using this value of K the values of PD and TJ can be obtained by solving first equations iteratively for any value of TA.

DC ELECTRICAL CHARACTERISTICS

$T_A = -40$ to 85°C unless otherwise specified.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_P	Positive Threshold	All I/O Lines V_{DD} = 3.0V	1.8	2.0	2.2	V
		V_{DD} = 4.5V	2.8	3.2	3.8	
		V_{DD} = 5.5V	3.6	4.0	4.4	
V_N	Negative Threshold	All I/O Lines V_{DD} = 3.0V	1.1	1.3	1.5	V
		V_{DD} = 4.5V	1.6	2.0	2.4	
		V_{DD} = 5.5V	2.0	2.4	2.8	
V_H	Hysteresis Voltage	All I/O Lines V_{DD} = 3.0V	0.6	0.8	0.9	V
		V_{DD} = 4.5V	0.9	1.2	1.4	
		V_{DD} = 5.5V	1.1	1.6	1.8	
V_{IL}	Input Low Level Voltage	RESET PIN V_{DD} = 3.0V			0.90	V
		V_{DD} = 4.5V			1.35	
		V_{DD} = 5.5V			1.65	
V_{IL}	Input Low Level Voltage	INT PIN V_{DD} = 3.0V			0.90	V
		V_{DD} = 4.5V			1.35	
		V_{DD} = 5.5V			1.65	
V_{IH}	Input High Level Voltage	RESET PIN V_{DD} = 3.0V	2.10			V
		V_{DD} = 4.5V	3.15			
		V_{DD} = 5.5V	3.85			
V_{IH}	Input High Level Voltage	INT PIN V_{DD} = 3.0V	2.10			V
		V_{DD} = 4.5V	3.15			
		V_{DD} = 5.5V	3.85			
V_{OL}	Low Level Output Voltage	All I/O Lines I_O < 1µA				V
		V_{DD} = 3.0V			0.1	
		V_{DD} = 5.5V			0.1	
V_{OL}	Low Level Output Voltage	All I/O Lines I_{OL} < 5mA				V
		V_{DD} = 4.5V			0.8	
		V_{DD} = 5.5V			0.8	
V_{OH}	High Level Output Voltage	All I/O Lines I_O < 1µA				V
		V_{DD} = 3.0V	2.9			
		V_{DD} = 5.5V	5.4			
V_{OH}	High Level Output Voltage	All I/O Lines I_{OH} = – 5mA				V
		V_{DD} = 4.5V	3.0			
		V_{DD} = 5.5V	4.0			

DC ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{IL}, I_{IH}	Input Leakage Current	All Digital Inputs Vin = V_{DD} or V_{SS}				µA
		V_{DD} = 3.0V		0.1	1.0	
		V_{DD} = 5.5V		0.1	1.0	
I_{IL}, I_{IH}	Input Leakage Current	All A/D Conv. Inputs Vin = V_{DD} or V_{SS}				µA
		V_{DD} = 3.0V		0.1	1.0	
		V_{DD} = 5.5V		0.1	1.0	
V_{ON}	Trigger Level ON Voltage	RESET V_{DD} = 3.0V			1.0	V
		V_{DD} = 4.5V			1.5	
		V_{DD} = 5.5V			1.7	
V_{OFF}	Trigger Level ON Voltage	RESET V_{DD} = 3.0V	2.0			V
		V_{DD} = 4.5V	3.0			
		V_{DD} = 5.5V	3.8			
I_{DD}	Supply Current RUN Mode	ILoad = 0mA F_{osc} = 0.5MHz V_{DD} = 3.0V			3.5	mA
		F_{osc} = 4MHz V_{DD} = 5.5V			5.0	mA
I_{DD}	Supply Current WAIT Mode	ILoad = 0mA F_{osc} = 0.5MHz V_{DD} = 3.0V			1.7	mA
		F_{osc} = 4MHz V_{DD} = 5.5V			2.5	mA
I_{DD}	Supply Current STOP Mode	Note ILoad = 0mA V_{DD} = 3.0V			20	µA
		V_{DD} = 5.5V			30	µA

AC ELECTRICAL CHARACTERISTICS

T_A = – 40 to 85°C unless otherwise specified.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
f_{OSC}	Oscillator Frequency	Crystal or External Clock V_{DD} = 3.0V	DC		0.5	
		V_{DD} = 4.5V	DC		4	
		V_{DD} = 5.5V	DC		4	
t_{SU}	Oscillator Start-up Time	V_{DD} = 3.0V			15	mS
		V_{DD} = 4.5V			10	
		V_{DD} = 5.5V			10	
C_{IN}	Input Capacitance	All Inputs Pins			10	pF
C_{OUT}	Output Capacitance	All Output Pins			15	pF

A/D ELECTRICAL CHARACTERISTICS

$T_A = -40$ to 85°C unless otherwise specified.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Res	Resolution		8	8	8	Bit
Lin	Non Linearity	Max Deviation from the Best Straight Line			± 1/2	LSB
Qe	Quantization Error	Uncertainly due to converter resolution.			± 1/2	LSB
ZO	Zero Offset Error	$V_I = AV_{SS}$			1	LSB
FSO	Full Scale Error	$V_I = AV_{DD}$			1	LSB
t_C	Conversion Time	f_{OSC} = 4MHz(1)		150		µs
V_{AN}	Conversion Range		AV_{SS}		AV_{DD}	V
ZIR	Zero Input Reading	Conversion result when $V_I = AV_{SS}$.	00			Hex
FSR	Full Scale Reading	Conversion result when $V_I = AV_{DD}$.			FF	Hex
AV_{SS} AV_{DD}	Analog Reference	(2)	V_{SS}		V_{DD}	V
AC_{IN}	Analog Input Capacitance				5	pF
ASI	Analog Source Impedance				30	KΩ
SSI	Analog Refer. Supply Imped.				2	KΩ

Notes : 1. With oscillator frequencies less than 1.2MHz, the A/D converter accuracy is decreased.
2. In ST6040/ST6041 Devices Analog V_{SS} and V_{DD} are internally connected to digital V_{SS} and V_{DD}.

TIMER CHARACTERISTICS

$T_A = -40$ to 85°C unless otherwise specified.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Res	Resolution		$\frac{1}{fo} \cdot 12$			s
f_{IN}	Input Frequency at TIMER Pin	V_{DD} = 3.0V V_{DD} = 4.5V		1/4 f_{OSC}		MHz

Note : Timer pin is available only on ST6041 timer 1.

LCD DRIVER CHARACTERISTICS

T_A = – 40 to 85°C unless otherwise specified.

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
fBP	Backplane Frequency	Fosc = 4MHz V_{DD} = 4.5V	80	80	80	Hz
VOS	DC Offset Voltage	V_{DD} = 3.0V V_{DD} = 4.5V			50	Mv
V_{OL}	Low Level Output Voltage	V_{DD} = 4.5V		0.5		V
V_{OH}	High Level Output Voltage	V_{DD} = 4.5V		0.5		V

ORDERING INFORMATION

The following chapter deals with the procedure for transfer the Program/Data ROM codes to SGS-THOMSON.

Communication of the ROM codes. To communicate the contents of Program/Data ROM memories to SGS-THOMSON, the customer has to send two 2764 EPROM that must be programmed as follows:

0000H-007FH Reserved (Should be filled with FFH)
0080H-0F9FH User program
0FA0H-0FFBH Reserved (Should be filled with FFH)
0FFCH Interrupt vector LOW byte
0FFDH Interrupt vector HIGH byte
0FFEH Reset vector LOW byte
0FFFH Reset vector HIGH byte

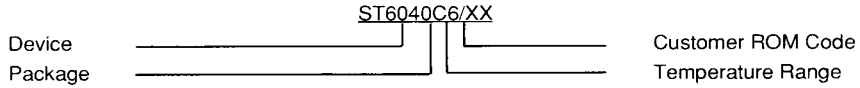
The Data ROM codes (64 Bytes) of the microcontroller must be placed in the EPROM from:

1140H-117FH

All unused bytes must be set to FFH. For shipment to SGS-THOMSON the EPROMs should be placed in a conductive IC carrier and packaged carefully.

Listing Generation & Verification. When SGS-THOMSON receives the EPROMs, they are compared and a computer listing is generated from them. This listing refers exactly to the mask that will be used to produce the microcontroller. Then the listing is returned to the customer that must thoroughly check, complete, sign and return it to SGS-THOMSON. SGS-THOMSON will also program one 2764 EPROM from the data file corresponding to the listing to help the customer in its verification. The signed listing constitutes a part of the contractual agreement for the creation of the customer mask. SGS-THOMSON sales organization will provide detailed information on contractual points.

ST6040 Part Number



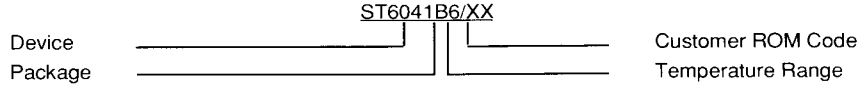
Device : ST6040

Package : C : 44 PLCC

Temperature range : – 40°C to 85°C 6
– 40°C to 110°C 7

Marking : it is by default equivalent to the sales type (part number). If a special marking is required see attached option list chart.

ST6041 Part Number



Device : ST6041

Package : B : 48 Plastic Dual-in-line

Temperature range : – 40°C to 85°C 6
– 40°C to 110°C 7

Marking : it is by default equivalent to the sales type (part number). If a special marking is required see attached option list.

ST604X MICROCONTROLLER OPTION LIST

Customer .....
Address .....
Contact .....
Phone No .....
Reference .....

Device [ ] (d)

Package [ ] (p)

Temperature Range [ ] (t)

For marking two lines with 10 characters maximum are possible

Special Marking [ ] (y/n) Line 1 "....." (M)
Line 2 "....." (M)

[d] 1 = ST6040, 2 = ST6041

[p] B=Plastic Dual in Line, C = PLCC

(t) 6 = – 40 to 85°C
7 = – 40 to 110°C

(M) Letters, digits, '.', '-', '/' and spaces only

Signature .....
Date .....