

### FEATURES

- ARM922T™ Core:
  - 32-bit ARM9TDMI™ RISC Core (200 MHz)
  - 16KB Cache: 8KB Instruction Cache and 8KB Data Cache
  - MMU (Windows CE™ Enabled)
- 80KB On-Chip Memory
- Vectored Interrupt Controller
- External Bus Interface
  - 100 MHz
  - Asynchronous SRAM/ROM/Flash
  - Synchronous DRAM/Flash
  - PCMCIA
  - Compact Flash
- Clock and Power Management
  - 32.768 kHz and 14.7456 MHz Oscillators
  - Programmable PLL
- Low Power Modes
  - Run (200 mA), Halt, Standby (35 µA)
- Programmable LCD Controller
  - Up to 1,024 × 768 Resolution
  - Supports STN, Color STN, HR-TFT, TFT
  - Up to 64 k-Colors and 15 Gray Shades
- 10 Channel, 10-bit A/D Converter
  - Touch Screen Controller
  - Brownout Detector
- DMA (12 Channels)
  - External DMA Channels
  - AAC (AC97)
  - MMC
  - USB
- USB Host and Device Interface (USB1.1)
- Synchronous Serial Port (SSP)
  - Motorola SPI™
  - Texas Instruments SSI
  - National MICROWIRE™
- PS/2 Keyboard/Mouse Interface (KMI)
- Three Programmable Timers
- Three UARTs
  - Classic IrDA (115 kbit/s)
- Smart Card Interface (ISO7816)
- Four Pulse Width Modulators (PWMs)
- MultiMediaCard Interface with Secure Digital (MMC 2.11/SD 1.0)
- AAC (AC97) Codec Interface
- Smart Battery Monitor Interface
- Real Time Clock (RTC)
- Up to 64 General Purpose I/O Channels
- Programmable Interrupt Controller
- Watchdog Timer
- JTAG Debug Interface and Boundary Scan
- Operating Voltage
  - 1.8 V Core
  - 3.3 V Input/Output (1.8 V I/O Optional\*)
- Temperature
  - 0°C to +70°C Commercial
  - -40°C to +85°C Industrial (With Clock Frequency Reduction\*)
- 324-Ball PBGA Package

### DESCRIPTION

The advent of 3G technology opens the door for a wide range of Multimedia applications in mobile information appliances. These appliances require high processing performance and low power consumption. The LH7A404 is designed from the ground up to provide high processing performance, low power consumption, and a high level of integration.

The LH7A404 contains a high performance 32-bit ARM922T Core. Power consumption is reduced by the high level of integration, 80KB on-chip SRAM, fully static design, power management unit, low voltage operation (1.8 V Core, 1.8 V or 3.3 V I/O) and on-chip PLL.

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**NOTE:** \*Under development. Results pending further characterization.

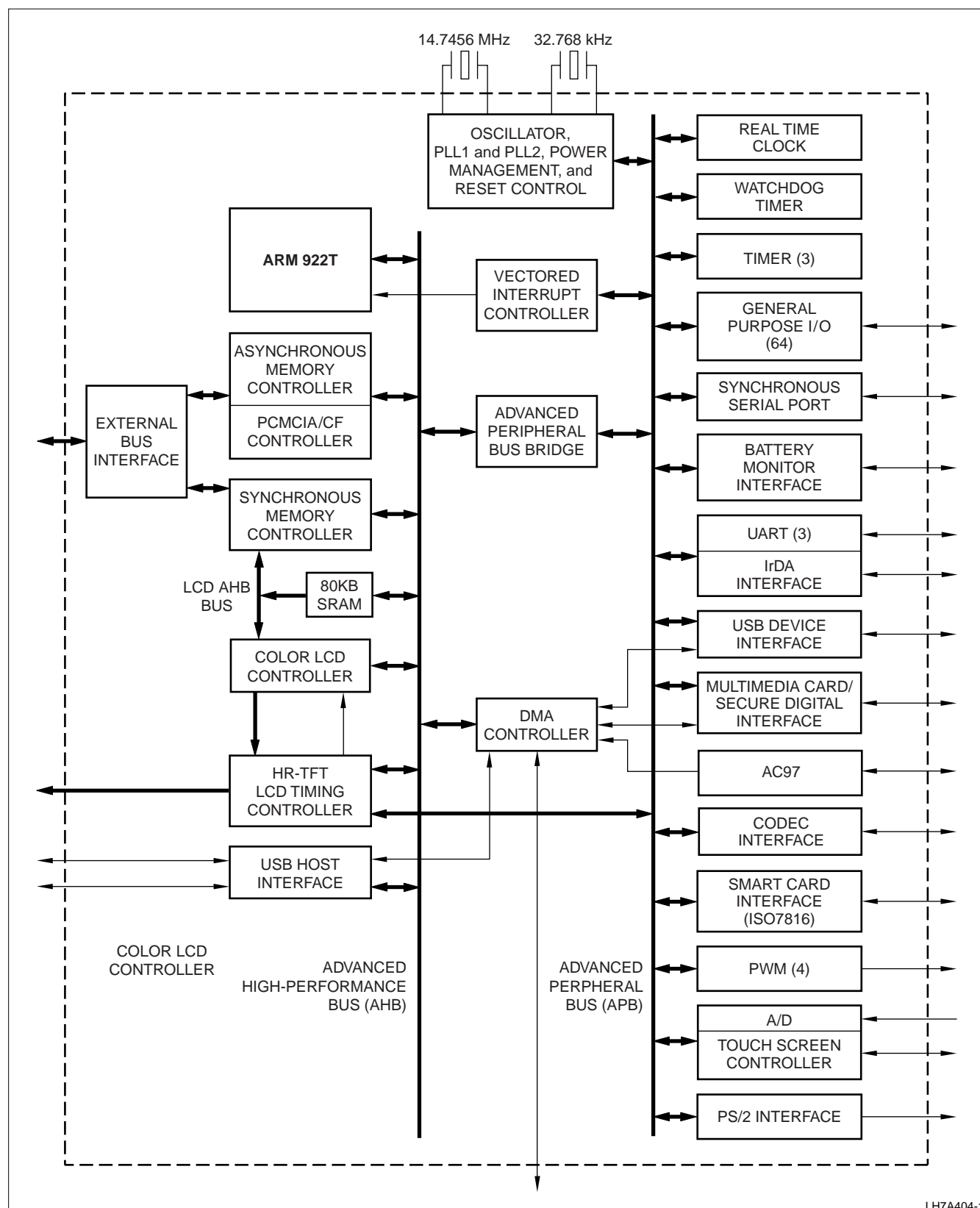


Figure 1. LH7A404 Block Diagram

LH7A404-1

Table 1. Functional Pin List

BGA	SIGNAL	DESCRIPTION	OUTPUT DRIVE
J9	VDD	I/O Ring Power	
K9			
M9			
N9			
P9			
P11			
P12			
P13			
P14			
N14			
M14			
L14			
K14			
J14			
J13			
J11			
J10			
E4	VSS	I/O Ring Ground	
H4			
L4			
R4			
W8			
W11			
W15			
W19			
T19			
P19			
M19			
K19			
G19			
D18			
D14			
D10			
D7			
K3	VDDC	Core Power	
Y5			
Y12			
V20			
N20			
H20			
D20			
C12			
C8			
F3			

Table 1. Functional Pin List (Cont'd)

BGA	SIGNAL	DESCRIPTION	OUTPUT DRIVE
G2	VSSC	Core Ground	
M2			
AA6			
AA15			
P21			
K21			
F21			
B17			
B10			
B5			
AA17	VDDA1	Analog Power for PLL1	
AB17	VSSA1	Analog Ground for PLL1	
AA18	VDDA2	Analog Power for PLL2	
AB18	VSSA2	Analog Ground for PLL2	
AB16	VDDA3	Analog Power for A/D, Touch Screen Controller	
AB13	VSSA3	Analog Ground for A/D, Touch Screen Controller	
D3	nPOR	Power on Reset	
E3	nURESET	User Reset	
D4	WAKEUP	Wake Up	
E1	nPWRFL	Power Fail Signal	2 mA
C2	nEXTPWR	External Power	
AA16	XTALIN	14.7456 MHz Crystal Oscillator pins. To drive the device from an external clock source, XTALIN can be used while XTALOUT is left unconnected.	
Y16	XTALOUT		
AA21	XTAL32IN	32.768 kHz Real Time Clock, Crystal Oscillator pins. To drive the device from an external clock source, XTAL32IN can be used while XTAL32OUT is left unconnected.	
Y20	XTAL32OUT		
L3	PGMCLK	Programmable Clock (14.7456 MHz MAX.)	8 mA
AB22	nCS0	Asynchronous Memory Chip Select 0 (ROM/Flash)	16 mA
N13	nCS1	Asynchronous Memory Chip Select 1	16 mA
Y21	nCS2	Asynchronous Memory Chip Select 2	16 mA
W20	nCS3/nMMCSEL	Asynchronous Memory Chip Select 3 and MMC Select	16 mA
Y22	nCS6	Asynchronous Memory Chip Select 6	16 mA
W21	nCS7	Asynchronous Memory Chip Select 7	16 mA

Table 1. Functional Pin List (Cont'd)

BGA	SIGNAL	DESCRIPTION	OUTPUT DRIVE
W22	D0	Data Bus	16 mA
V21	D1		
U22	D2		
U20	D3		
T22	D4		
T20	D5		
R21	D6		
R19	D7		
P20	D8		
N21	D9		
M22	D10		
M20	D11		
L21	D12		
L19	D13		
K20	D14		
J21	D15		
J19	D16		
H21	D17		
G22	D18		
G20	D19		
F20	D20		
E22	D21		
E20	D22		
D22	D23		
C22	D24		
B22	D25		
B21	D26		
D19	D27		
B20	D28		
A20	D29		
B19	D30		
B18	D31		
A1	TDI	JTAG Data In. This signal should be pulled-up to VDD	
V22	A0	Address Bus	16 mA
V19	A1		
U21	A2/SA0	Address Bus and Synchronous Address Bus	16 mA
U19	A3/SA1		
T21	A4/SA2		
R22	A5/SA3		
R20	A6/SA4		
P22	A7/SA5		
N22	A8/SA6		
N19	A9/SA7		
M21	A10/SA8		
L22	A11/SA9		
L20	A12/SA10		
K22	A13/SA11		
J22	A14/SA12		
J20	A15/SA13		

Table 1. Functional Pin List (Cont'd)

BGA	SIGNAL	DESCRIPTION	OUTPUT DRIVE
H22	A16/SBANK0	Address Bus and Synchronous Bank 0	16 mA
H19	A17/SBANK1	Address Bus and Synchronous Bank 1	16 mA
G21	A18	Address Bus	16 mA
F22	A19		
F19	A20		
E21	A21		
E19	A22		
D21	A23		
C21	A24		
A18	A25		
A17	A26		
C17	A27		
C14	nOE	Asynchronous Memory Output Enable	16 mA
A13	nWE0	Asynchronous Memory Write Enable 0	16 mA
M13	nWAIT	Asynchronous Memory Controller Wait	
A16	SCKEN3	Clock Enable 3 for Synchronous Memory	16 mA
B16	SCLK	Synchronous Memory Clock <sup>2</sup>	24 mA
C16	SCKE1	Clock Enable 1 for Synchronous Memory	16 mA
D16	SCKE0	Clock Enable 0 for Synchronous Memory	16 mA
A22	nSCS0	Synchronous Memory Chip Select 0	16 mA
C20	nSCS1	Synchronous Memory Chip Select 1	16 mA
A21	nSCS2	Synchronous Memory Chip Select 2	16 mA
C19	nSCS3	Synchronous Memory Chip Select 3	16 mA
A19	nSWE	Synchronous Memory Write Enable	16 mA
M3	PA0/LCDVD16	GPIO Port A and LCD data pins 16 and 17	8 mA
M1	PA1/LCDVD17		
N4	PA2	GPIO Port A	8 mA
N3	PA3		
N2	PA4		
N1	PA5		
P4	PA6		
P3	PA7		
P2	PB0/UARTRXD1	GPIO Port B and UART1 Receive Data Input	8 mA
L10	PB1/UARTTXD3	GPIO Port B and UART3 Transmit Data Out	8 mA
L11	PB2/UARTRXD3	GPIO Port B and UART3 Receive Data In	8 mA
M10	PB3/UARTCTS3	GPIO Port B and UART3 Clear to Send	8 mA
M11	PB4/UARTDCD3	GPIO Port B and UART3 Data Carrier Detect	8 mA
N10	PB5/UARTDSR3	GPIO Port B and UART3 Data Set Ready	8 mA
P1	PB6/BMISWIB/BMISMBIO	GPIO Port B and Battery Monitor Interface	8 mA
R1	PB7/BMISMBCLK		
R2	PC0/TXD1	GPIO Port C and UART1 Transmit Data Output	16 mA
R3	PC1	GPIO Port C	16 mA
T1	PC2	GPIO Port C	16 mA
T2	PC3	GPIO Port C	16 mA
T3	PC4	GPIO Port C	16 mA
T4	PC5	GPIO Port C	16 mA
U1	PC6	GPIO Port C	16 mA
U2	PC7	GPIO Port C	16 mA

Table 1. Functional Pin List (Cont'd)

BGA	SIGNAL	DESCRIPTION	OUTPUT DRIVE
AB10	PD0/LCDVD8	GPIO Port D and LCD Video Data Interface	16 mA
AA10	PD1/LCDVD9		
Y10	PD2/LCDVD10		
W10	PD3/LCDVD11		
AB11	PD4/LCDVD12		
AA11	PD5/LCDVD13		
Y11	PD6/LCDVD14		
AB12	PD7/LCDVD15	GPIO Port E and LCD Video Data Interface	16 mA
AA8	PE0/LCDVD4		
AA9	PE1/LCDVD5		
Y9	PE2/LCDVD6		
W9	PE3/LCDVD7	GPIO Port E	16 mA
C4	PE4		
A3	PE5		
B3	PE6		
A2	PE7	GPIO Port F and Smart Card Interface. Can be used for external interrupts. Interrupts can be level or edge triggered and are internally debounced.	8 mA
L13	PF0		
K13	PF1		
L12	PF2		
K12	PF3		
J12	PF4		
K11	PF5/SCIDTECT		
C10	PF6		
A9	PF7	GPIO Port G/Compact Flash Output Enable	8 mA
W4	PG0/nCFOE		
AA1	PG1/nCFWE	GPIO Port G/Compact Flash Write Enable	8 mA
AA2	PG2/nCFIORD	GPIO Port G/Compact Flash I/O read strobe	8 mA
AB1	PG3/nCFIOWR	GPIO Port G/Compact Flash I/O write strobe	8 mA
AB2	PG4/nCFREG	GPIO Port G/Compact Flash Register memory access	8 mA
AA3	PG5/nCFCE1	GPIO Port G/Compact Flash Chip Enable 1	8 mA
AB3	PG6/nCFCE2	GPIO Port G/Compact Flash Chip Enable 2	8 mA
Y3	PG7/PCDIR	GPIO Port G/PC Card Direction	8 mA
AB4	PH0/CFRESETA	GPIO Port H/Compact Flash Reset A	8 mA
AA4	PH1/CFA8/CFA24/ CFRESETB	GPIO Port H/Compact Flash Address Bit 8/PCMCIA1 Address Bit 24/PCMCIA2 Reset B	8 mA
Y4	PH2/nCFENA	GPIO Port H/Compact Flash Enable A	8 mA
AB5	PH3/CFA9/CFA25/nCFENB	GPIO Port H/Compact Flash Address Bit 9/PCMCIA1 Address Bit 25/PCMCIA2 Enable B	8 mA
AA5	PH4/nCFWAIT/nCFWAITA	GPIO Port H/Compact Flash WAIT Signal/PCMCIA WAIT A	8 mA
W5	PH5/CFA10/nCFWAITB	GPIO Port H/Compact Flash Address Bit 10/PCMCIA2 WAIT B	8 mA
AB6	PH6/AC97RESET	GPIO Port H/AC97 reset	8 mA
Y6	PH7/nCFSTATEN	GPIO Port H/Compact Flash Status Read Enable	8 mA
U3	LCDFP/LCDSPS	LCD Frame Pulse / HR-TFT Reset Row Driver Counter	16 mA
V1	LCDLP/LCDHRLP	LCD Linepulse / HR-TFT Latch Pulse	16 mA
U4	LCDCLS	HR-TFT Clock for Row Drivers	16 mA
V2	LCDSPLE	HR-TFT Start Pulse Left for reverse scanning	16 mA
V3	LCDUBL	HR-TFT Up, Down signal for reverse scanning	16 mA
V4	LCDSPR	HR-TFT Start Pulse Right for normal scanning	16 mA
W1	LCDLBR	HR-TFT Output for reverse scanning	16 mA

Table 1. Functional Pin List (Cont'd)

BGA	SIGNAL	DESCRIPTION	OUTPUT DRIVE
W2	LCDMOD	HR-TFT MOD Signal used by the row driver	16 mA
W3	LCDPS	HR-TFT Power Save	16 mA
Y1	LCDCLPOWER	HR-TFT Power Sequence Control	16 mA
Y2	LCDREV	HR-TFT Reverse	16 mA
W6	LCDCLKIN	External Clock Input for LCD controller	
AA7	LCDVD0	LCD Video Data Interface	16 mA
Y7	LCDVD1		
W7	LCDVD2		
AB8	LCDVD3		
P10	LCDM	AC bias for LCD. This signal is used on STN displays	16 mA
AB9	LCDDCLK	LCD Pixel Clock	16 mA
W17	USBDPCP	USB Device control	
Y18	USBDP	USB Data Positive (Differential Pair)	
W18	USBDN	USB Data Negative (Differential Pair)	
AB19	USBHDP0	USB Data Host Positive 0 (Differential Pair)	
AA19	USBHDN0	USB Data Host Negative 0 (Differential Pair)	
AB20	USBHDP1	USB Data Host Positive 1(Differential Pair)	
AA20	USBHDN1	USB Data Host Negative 1(Differential Pair)	
Y19	USBHPWR	USB Host Power	
AB21	USBHOVRCURR	USB Overcurrent	
B12	PWMEN0	DC-DC Converter 0 Enable	8 mA
D12	PWMEN1	DC-DC Converter 1 Enable	8 mA
A11	PWM0	DC-DC Converter 0 Output (Pulse Width Modulated)	8 mA
B11	PWM1	DC-DC Converter 1 Output (Pulse Width Modulated)	8 mA
C11	PWM2	PWM Output 2	8 mA
D11	PWM3	PWM Output 3	8 mA
A10	PWMSYNC0	PWM Synchronizing Input	
B9	AC97CLK	AC97 Codec Clock (AAC/Normal)	8 mA
C9	AC97OUT	AC97 Codec Output (AAC/Normal)	8 mA
D9	AC97SYNC	AC97 Codec Sync (AAC/Normal)	8 mA
A8	AC97IN	AC97 Codec Input (AAC/Normal)	8 mA
B8	MMCCLK/SPICLK	MultiMediaCard Clock (20 MHz MAX.)/optional SPI Mode Clock	8 mA
D8	MMCCMD/SPIDI	MultiMediaCard Command/optional SPI mode Data In	8 mA
A7	MMCDATA0/SPIDO	MultiMediaCard Data/optional SPI mode Data Out	8 mA
B7	MMCDATA1	MultiMediaCard Data 1	8 mA
C7	MMCDATA2	MultiMediaCard Data 2	8 mA
A6	MMCDATA3	MultiMediaCard Data 3	8 mA
F4	UARTCTS2	UART2 Clear to Send Signal	8 mA
E2	UARTDCD2	UART2 Data Carrier Detect Signal	8 mA
K10	UARTDSR2	UART2 Data Send Ready Signal	8 mA
F2	UARTTX1/UARTIRTX1	UART1 Transmit / IrDA Transmit	8 mA
F1	UARTRX1/UARTIRRX1	UART1 Receive / IrDA Receive	8 mA
G4	UARTTXD2	UART2 Transmit Data Output	8 mA
G3	UARTRXD2	UART2 Receive Data Input	8 mA
K1	SSPCLK	Synchronous Serial Port Clock	8 mA
L2	SSPRX	Synchronous Serial Port Receive	8 mA
L1	SSPTX	Synchronous Serial Port Transmit	8 mA
M4	SSPFRM	Synchronous Serial Port Frame Sync	8 mA



Table 1. Functional Pin List (Cont'd)

BGA	SIGNAL	DESCRIPTION	OUTPUT DRIVE
H2	COL0	Keyboard Interface	8 mA
H1	COL1		
J4	COL2		
J3	COL3		
J2	COL4		
J1	COL5		
K4	COL6		
K2	COL7		
B1	TCLK	JTAG Clock. This signal should be pulled-up to VDD	
B2	TDO	JTAG Data Out	4 mA
C1	TMST	JTAG Test Mode Select. This signal should be pulled-up to VDD	
C3	MEDCHG	Media Change for Smart Card interface	
D1	BATOK	Battery OK	
D2	nBATCHG	Battery Change	
G1	KMIDAT	Keyboard / Mouse data	16 mA
H3	KMICLK	Keyboard /Mouse clock	16 mA
L9	BUZ	Buzzer Output (254 kHz MAX.)	8 mA
AB7	nBLE2	Byte Lane Enable 2	16 mA
Y8	nBLE1	Byte Lane Enable 1	16 mA
AA12	BATCNTL	Battery Control for A/D controller battery monitor.	16 mA
N11	BOOTWIDTH0	Boot Width Pins. Used with the MEDCHG bit. On power up, the values on these pins are latched to determine the width and type of Boot device. Boot width can be 8-, 16-, or 32-bit.	
N12	BOOTWIDTH1		
W12	LR_YM	Touch Screen Controller Lower Right Y-minus	
AA13	AN1	A/D channel 1	
Y13	AN6	A/D channel 6	
W13	LL_YP	Touch Screen Controller Lower Left Y-plus	
AB14	AN5	A/D channel 5	
AA14	AN2	A/D channel 2	
Y14	UR_XM	Touch Screen Controller Upper Right X-minus	
W14	AN4	A/D channel 4	
AB15	AN3	A/D channel 3	
Y15	UL_XP	Touch Screen Controller Upper Left X-plus,	
W16	nTEST0	Test Pins. Tie to VDD.	
Y17	nTEST1		
AA22	OSCEN	Oscillator Enable Output	8 mA
C18	nCAS	Column Address Strobe Signal	16 mA
D17	nRAS	Row Address Strobe Signal	16 mA
A15	nBLE3	Byte Lane Enable 3	8 mA
B15	nBLE0	Byte Lane Enable 0	8 mA
C15	DQM0	Data Mask for synchronous memories	16 mA
D15	DQM1		
A14	DQM2		
B14	DQM3		
B13	SCIIO	Smart Card Interface I/O	16 mA
C13	SCICLK	Smart Card Interface Clock	16 mA
D13	SCIRESET	Smart Card Interface Reset	16 mA
A12	SCIVCCEN	Smart Card Interface VCC Enable	16 mA

Table 1. Functional Pin List (Cont'd)

BGA	SIGNAL	DESCRIPTION	OUTPUT DRIVE
B6	CTCLKIN	Counter Timer Clock Input	
C6	nRESETOUT	Reset Output to external devices	16 mA
D6	DREQ0	DMA Request 0	
A5	DACK0	DMA Acknowledge 0	16 mA
C5	DEOT0	DMA End Of Transfer 0	16 mA
D5	DREQ1	DMA Request 1	
A4	DACK1	DMA Acknowledge 1	16 mA
B4	DEOT1	DMA End Of Transfer 1	16 mA

**NOTES:**

1. Signals beginning with 'n' are Active LOW.
2. The SCLK pin can source up to 16 mA and sink up to 24 mA.  
See 'DC Characteristics'.

Table 2. LCD Pin Muxing

PIN ASSIGNED	4-BIT MONO STN SINGLE PANEL	8-BIT MONO STN SINGLE PANEL	COLOR STN SINGLE PANEL	COLOR STN DUAL PANEL	16-BIT TFT
DD0	MUSTN3	MUSTN7	CUSTN7	CUSTN7	RED0
DD1	MUSTN2	MUSTN6	CUSTN6	CUSTN6	RED1
DD2	MUSTN1	MUSTN5	CUSTN5	CUSTN5	RED2
DD3	MUSTN0	MUSTN4	CUSTN4	CUSTN4	RED3
DD4		MUSTN3	CUSTN3	CUSTN3	RED4
DD5		MUSTN2	CUSTN2	CUSTN2	GREEN0
DD6		MUSTN1	CUSTN1	CUSTN1	GREEN1
DD7		MUSTN0	CUSTN0	CUSTN0	GREEN2
DD8				CLSTN7	GREEN3
DD9				CLSTN6	GREEN4
DD10				CLSTN5	BLUE0
DD11				CLSTN4	BLUE1
DD12				CLSTN3	BLUE2
DD13				CLSTN2	BLUE3
DD14				CLSTN1	BLUE4
DD15				CLSTN0	Intensity

**NOTES:**

1. The Intensity bit is identically generated for all three colors.
2. MU = Monochrome Upper
3. CU = Color Upper
4. CL = Color Lower

Table 3. Detailed Pin List

BGA	SIGNAL	RESET STATE	STANDBY STATE	PULL UP	SCHMITT	I/O	SLEW RATE	OUTPUT DRIVE
J9	VDD	I/O Ring Power						
K9								
M9								
N9								
P9								
P11								
P12								
P13								
P14								
N14								
M14								
L14								
K14								
J14								
J13								
J11								
J10								
E4	VSS	I/O Ring Ground						
H4								
L4								
R4								
W8								
W11								
W15								
W19								
T19								
P19								
M19								
K19								
G19								
D18								
D14								
D10								
D7								
K3	VDDC	Core Power						
Y5								
Y12								
V20								
N20								
H20								
D20								
C12								
C8								
F3								

Table 3. Detailed Pin List (Cont'd)

BGA	SIGNAL	RESET STATE	STANDBY STATE	PULL UP	SCHMITT	I/O	SLEW RATE	OUTPUT DRIVE
G2	VSSC	Core Ground						
M2								
AA6								
AA15								
P21								
K21								
F21								
B17								
B10								
B5								
AA17	VDDA1	Analog Power for PLL1						
AB17	VSSA1	Analog Ground for PLL1						
AA18	VDDA2	Analog Power for PLL2						
AB18	VSSA2	Analog Ground for PLL2						
AB16	VDDA3	Analog Power for TSC						
AB13	VSSA3	Analog Ground for TSC						
A1	TDI	Input	Input	Yes		I		
B1	TCLK	Input	Input	Yes	Yes	I		
B2	TDO	LOW	No Change			O	100 mA/ns	4 mA
C1	TMST	Input	No Change	Yes		I		
D3	nPOR	Input	Input		Yes	I		
C2	nEXTPWR	Input	Input		Yes	I		
C3	MEDCHG	Input	Input		Yes	I		
D1	BATOK	Input	Input		Yes	I		
D2	nBATCHG	Input	Input		Yes	I		
E3	nURESET	Input	Input		Yes	I		
D4	WAKEUP	Input	Input		Yes	I		
F4	UARTCTS2	Input	Input			I/O	110 mA/ns	8 mA
E2	UARTDCD2	Input	Input			I/O	110 mA/ns	8 mA
E1	nPWRFL	Input	Input		Yes	I		
K10	UARTDSR2	Input	Input			I/O	110 mA/ns	8 mA
F2	UARTTX1/UARTIRTX1	LOW	No Change			I/O	110 mA/ns	8 mA
F1	UARTRX1/UARTIRRX1	Input	Input			I/O	110 mA/ns	8 mA
G4	UARTTXD2	LOW	No Change			I/O	110 mA/ns	8 mA
G3	UARTRXD2	Input	Input			I/O	110 mA/ns	8 mA
G1	KMIDAT	Input	No Change	Ext		I/O	95 mA/ns	16 mA
H3	KMICLK	Input	No Change	Ext		I/O	95 mA/ns	16 mA

Table 3. Detailed Pin List (Cont'd)

BGA	SIGNAL	RESET STATE	STANDBY STATE	PULL UP	SCHMITT	I/O	SLEW RATE	OUTPUT DRIVE
H2	COL0	HIGH	HIGH	HIGH		I/O	100 mA/ns	8 mA
H1	COL1							
J4	COL2							
J3	COL3							
J2	COL4							
J1	COL5							
K4	COL6							
K2	COL7							
L9	BUZ	LOW	LOW			I/O	110 mA/ns	8 mA
K1	SSPCLK	LOW	LOW			I/O	110 mA/ns	8 mA
L3	PGMCLK	LOW	LOW			I/O	110 mA/ns	8 mA
L2	SSPRX	Input	LOW			I/O	110 mA/ns	8 mA
L1	SSPTX	Input	LOW			I/O	110 mA/ns	8 mA
M4	SSPFRM	HIGH	Input			I/O	110 mA/ns	8 mA
M3	PA0/LCDVD16	Input	No Change			I/O	110 mA/ns	8 mA
M1	PA1/LCDVD17							
N4	PA2	GPIO Port A	No Change			I/O	110 mA/ns	8 mA
N3	PA3							
N2	PA4							
N1	PA5							
P4	PA6							
P3	PA7							
P2	PB0/UARTRXD1	Input	No Change			I/O	110 mA/ns	8 mA
L10	PB1/UARTTXD3	Input	LOW if UART3 enabled else No Change			I/O	110 mA/ns	8 mA
L11	PB2/UARTRXD3	Input	No Change			I/O	110 mA/ns	8 mA
M10	PB3/UARTCTS3	Input	No Change			I/O	110 mA/ns	8 mA
M11	PB4/UARTDCD3	Input	No Change			I/O	110 mA/ns	8 mA
N10	PB5/UARTDSR3	Input	No Change			I/O	110 mA/ns	8 mA
P1	PB6/BMISWIB/BMISMBIO	Input	Input if SMB enabled else No Change					
R1	PB7/BMISMBCLK							
R2	PC0/TXD1	LOW	No Change			I/O	95 mA/ns	16 mA
R3	PC1	LOW	No Change			I/O	95 mA/ns	16 mA
T1	PC2							
T2	PC3							
T3	PC4							
T4	PC5							
U1	PC6							
U2	PC7							
U3	LCDFP/LCDSPS	LOW	LOW when not in HR-TFT mode			I/O	95 mA/ns	16 mA
U4	LCDCLS	LOW	No Change			I/O	95 mA/ns	16 mA
V1	LCDLP/LCDHRLP	LOW	LOW when not in HR-TFT mode			I/O	95 mA/ns	16 mA
V2	LCDSPPL	LOW	No Change			I/O	95 mA/ns	16 mA
V3	LCDUBL	LOW	No Change			I/O	95 mA/ns	16 mA

Table 3. Detailed Pin List (Cont'd)

BGA	SIGNAL	RESET STATE	STANDBY STATE	PULL UP	SCHMITT	I/O	SLEW RATE	OUTPUT DRIVE
V4	LCDSPR	LOW	No Change			I/O	95 mA/ns	16 mA
W1	LCDLBR	HIGH	No Change			I/O	95 mA/ns	16 mA
W2	LCDMOD	HIGH	No Change			I/O	95 mA/ns	16 mA
W3	LCDPS	HIGH	No Change			I/O	95 mA/ns	16 mA
Y1	LCDCLPOWER	LOW	No Change			I/O	95 mA/ns	16 mA
Y2	LCDREV	HIGH	No Change			I/O	95 mA/ns	16 mA
W4	PG0/nCFOE	LOW	No Change			I/O	110 mA/ns	8 mA
AA1	PG1/nCFWE							
AA2	PG2/nCFIORD							
AB1	PG3/nCFIOWR							
AB2	PG4/nCFREG							
AA3	PG5/nCFCE1							
AB3	PG6/nCFCE2							
Y3	PG7/PCDIR	Input	No Change			I/O	110 mA/ns	8 mA
AB4	PH0/CFRESETA							
AA4	PH1/CFA8/CFA24/ CFRESETB							
Y4	PH2/nCFENA							
AB5	PH3/CFA9/CFA25/nCFENB							
AA5	PH4/nCFWAIT/nCFWAITA							
W5	PH5/CFA10/nCFWAITB							
AB6	PH6/AC97RESET	Input	No Change			I		
Y6	PH7/nCFSTATEN							
W6	LCDCLKIN	Input	No Change			I		
AB7	nBLE2	HIGH	HIGH			I/O	95 mA/ns	16 mA
AA7	LCDVD0	LOW	LOW			I/O	95 mA/ns	16 mA
Y7	LCDVD1							
W7	LCDVD2							
AB8	LCDVD3							
AA8	PE0/LCDVD4	Input	LOW if 8 bit LCD enabled else No Change			I/O	95 mA/ns	16 mA
Y8	nBLE1	HIGH	HIGH			I/O	95 mA/ns	16 mA
P10	LCDM	LOW	LOW			I/O	95 mA/ns	16 mA
AB9	LCDDCLK	LOW	LOW			I/O	95 mA/ns	16 mA
AA9	PE1/LCDVD5	Input	LOW if 8 bit LCD enabled else No Change			I/O	95 mA/ns	16 mA
Y9	PE2/LCDVD6							
W9	PE3/LCDVD7							
AB10	PD0/LCDVD8	LOW	LOW if Dual Panel LCD else No Change			I/O	95 mA/ns	16 mA
AA10	PD1/LCDVD9							
Y10	PD2/LCDVD10							
W10	PD3/LCDVD11							
AB11	PD4/LCDVD12							
AA11	PD5/LCDVD13							
Y11	PD6/LCDVD14							
AB12	PD7/LCDVD15							

Table 3. Detailed Pin List (Cont'd)

BGA	SIGNAL	RESET STATE	STANDBY STATE	PULL UP	SCHMITT	I/O	SLEW RATE	OUTPUT DRIVE
AA12	BATCNTL	Input	No Change			I/O	95 mA/ns	16 mA
N11	BOOTWIDTH0	Input	Input		Yes	I		
N12	BOOTWIDTH1							
W12	LR_YM	A/D Inputs	A/D Inputs					
AA13	AN1							
Y13	AN6							
W13	LL_YP							
AB14	AN5							
AA14	AN2							
Y14	UR_XM							
W14	AN4							
AB15	AN3							
Y15	UL_XP							
AA16	XTALIN	Oscillator						
Y16	XTALOUT							
W16	nTEST0	Input	Input	Yes		I		
Y17	nTEST1							
W17	USBDCP	Input	Input			I		
Y18	USBDP	HIGH	HIGH	Yes				
W18	USBDN	LOW	LOW					
AB19	USBHDP0	HIGH	HIGH			I/O		
AA19	USBHDN0	LOW	LOW			I/O		
AB20	USBHDP1	HIGH	HIGH			I/O		
AA20	USBHDN1	LOW	LOW			I/O		
Y19	USBHPWR	HIGH	HIGH			O	95 mA/ns	16 mA
AB21	USBHOVRCURR	Input	No Change			I		
AB22	nCS0	HIGH	HIGH			I/O	95 mA/ns	16 mA
AA21	XTAL32IN	Oscillator						
Y20	XTAL32OUT							
N13	nCS1	HIGH	HIGH			I/O	95 mA/ns	16 mA
AA22	OSCEN	LOW	LOW			I/O	110 mA/ns	8 mA
Y21	nCS2	HIGH	HIGH			I/O	95 mA/ns	16 mA
W20	nCS3/nMMCSEL	HIGH	HIGH			I/O	95 mA/ns	16 mA
Y22	nCS6	HIGH	No Change			I/O	95 mA/ns	16 mA
W21	nCS7	HIGH	No Change			I/O	95 mA/ns	16 mA
M13	nWAIT	Asynchronous Memory Controller Wait				I/O	95 mA/ns	

Table 3. Detailed Pin List (Cont'd)

BGA	SIGNAL	RESET STATE	STANDBY STATE	PULL UP	SCHMITT	I/O	SLEW RATE	OUTPUT DRIVE
W22	D0	LOW	LOW			I/O	95 mA/ns	16 mA
v21	D1							
U22	D2							
U20	D3							
T22	D4							
T20	D5							
R21	D6							
R19	D7							
P20	D8							
N21	D9							
M22	D10							
M20	D11							
L21	D12							
L19	D13							
K20	D14							
J21	D15							
J19	D16							
H21	D17							
G22	D18							
G20	D19							
F20	D20							
E22	D21							
E20	D22							
D22	D23							
C22	D24							
B22	D25							
B21	D26							
D19	D27							
B20	D28							
A20	D29							
B19	D30							
B18	D31							
V22	A0	HIGH	HIGH			I/O	95 mA/ns	16 mA
V19	A1							



Table 3. Detailed Pin List (Cont'd)

BGA	SIGNAL	RESET STATE	STANDBY STATE	PULL UP	SCHMITT	I/O	SLEW RATE	OUTPUT DRIVE
U21	A2/SA0	LOW	LOW				95 mA/ns	16 mA
U19	A3/SA1							
T21	A4/SA2							
R22	A5/SA3							
R20	A6/SA4							
P22	A7/SA5							
N22	A8/SA6							
N19	A9/SA7							
M21	A10/SA8							
L22	A11/SA9							
L20	A12/SA10							
K22	A13/SA11							
J22	A14/SA12							
J20	A15/SA13							
H22	A16/SBANK0							
H19	A17/SBANK1							
G21	A18							
F22	A19							
F19	A20							
E21	A21							
E19	A22							
D21	A23							
C21	A24							
A18	A25							
A17	A26							
C17	A27							
A22	nSCS0	HIGH	HIGH			I/O	95 mA/ns	16 mA
C20	nSCS1							
A21	nSCS2							
C19	nSCS3							
A19	nSWE	HIGH	HIGH			I/O	95 mA/ns	16 mA
C18	nCAS	HIGH	HIGH			I/O	95 mA/ns	16 mA
D17	nRAS	HIGH	HIGH			I/O	95 mA/ns	16 mA
A16	SCKEN3	Depends on MEDCHG	LOW			I/O	95 mA/ns	16 mA
B16	SCLK	LOW	No Change			I/O	190 mA/ns	24 mA
C16	SCKE12	HIGH	No Change			I/O	95 mA/ns	16 mA
D16	SCKE0	HIGH	No Change			I/O	95 mA/ns	16 mA
A15	nBLE3	HIGH	No Change			I/O	110 mA/ns	8 mA
B15	nBLE0	HIGH	No Change			I/O	110 mA/ns	8 mA
C15	DQM0	Data Mask for Synchronous Memories				I/O	95 mA/ns	16 mA
D15	DQM1							
A14	DQM2							
B14	DQM3							
C14	nOE	HIGH	HIGH			I/O	95 mA/ns	16 mA
A13	nWE0	HIGH	HIGH			I/O	95 mA/ns	16 mA

Table 3. Detailed Pin List (Cont'd)

BGA	SIGNAL	RESET STATE	STANDBY STATE	PULL UP	SCHMITT	I/O	SLEW RATE	OUTPUT DRIVE
B13	SCIIO	Input	LOW			I/O	95 mA/ns	16 mA
C13	SCICLK	Input	LOW			I/O	95 mA/ns	16 mA
D13	SCIRESET	Input	LOW			I/O	95 mA/ns	16 mA
A12	SCIVCCEN	LOW	No Change			O	95 mA/ns	16 mA
B12	PWMEN0	HIGH/LOW	HIGH/LOW			I/O	110 mA/ns	8 mA
D12	PWMEN1	HIGH/LOW	HIGH/LOW			I/O	110 mA/ns	8 mA
A11	PWM0	Input	No Change			I/O	110 mA/ns	8 mA
B11	PWM1	Input	No Change			I/O	110 mA/ns	8 mA
C11	PWM2	Input	No Change			I/O	110 mA/ns	8 mA
D11	PWM3	Input	No Change			I/O	110 mA/ns	8 mA
A10	PWMSYNC0	Input	No Change			I/O	110 mA/ns	
L13	PF0	Input	No Change			I/O	110 mA/ns	8 mA
K13	PF1							
L12	PF2							
K12	PF3							
J12	PF4							
K11	PF5/SCIDTECT							
C10	PF6							
A9	PF7							
B9	AC97CLK	Input	Input			I/O	110 mA/ns	8 mA
C9	AC97OUT	LOW	LOW			I/O	110 mA/ns	8 mA
D9	AC97SYNC	LOW	LOW			I/O	110 mA/ns	8 mA
A8	AC97IN	Input	Input			I/O	110 mA/ns	8 mA
B8	MMCCCLK/SPICLK	LOW	LOW			I/O	110 mA/ns	8 mA
D8	MMCCMD/SPIDI	Input	Input			I/O	110 mA/ns	8 mA
A7	MMCDATA0/SPIDO	Input	Input			I/O	110 mA/ns	8 mA
B7	MMCDATA1	Input	Input			I/O	110 mA/ns	8 mA
C7	MMCDATA2	Input	Input			I/O	110 mA/ns	8 mA
A6	MMCDATA3	Input	Input			I/O	110 mA/ns	8 mA
B6	CTCLKIN	Input	No Change			I		
C6	nRESETOUT	LOW	HIGH			O	95 mA/ns	16 mA
D6	DREQ0	Input	No Change			I		
A5	DACK0	Input	No Change			I/O	95 mA/ns	16 mA
C5	DEOT0	Input	No Change			I/O	95 mA/ns	16 mA
D5	DREQ1	Input	No Change			I		
A4	DACK1	Input	No Change			I/O	95 mA/ns	16 mA
B4	DEOT1	Input	No Change			I/O	95 mA/ns	16 mA
C4	PE4	Input	Input			I/O	95 mA/ns	16 mA
A3	PE5							
B3	PE6							
A2	PE7							

**NOTE:** 'No Change' means the pin remains as it was programmed prior to entering the Standby state.

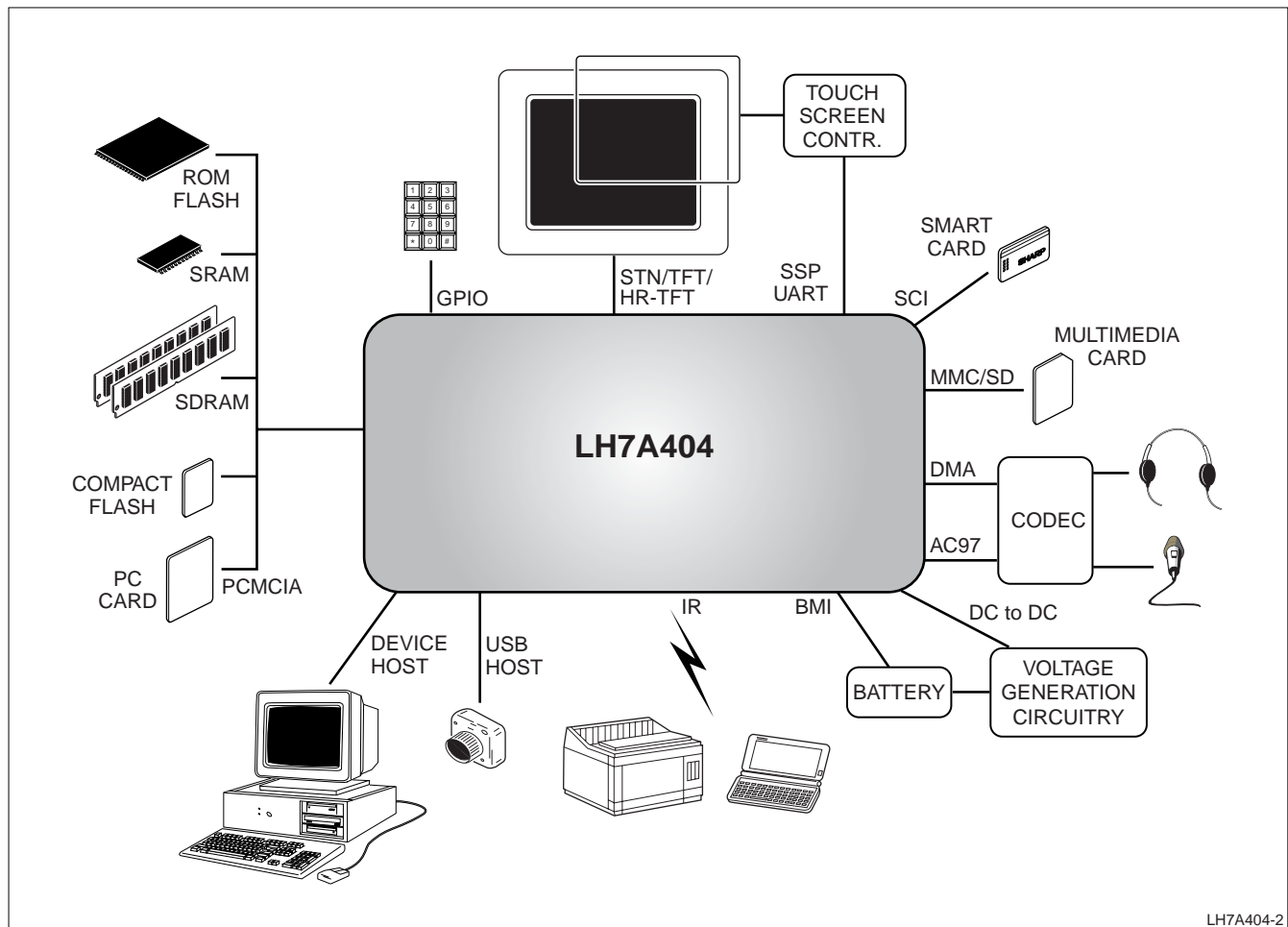


Figure 2. Application Diagram

## SYSTEM DESCRIPTIONS

### ARM922T Processor

The LH7A404 microcontroller features the ARM922T cached core with an Advanced High-performance Bus (AHB) interface. The processor is a member of the ARM9T family of processors. For more information, see the ARM document, 'ARM922T Technical Reference Manual', available on ARM's website at [www.arm.com](http://www.arm.com).

### Clock and State Controller

The clocking scheme in the LH7A404 is based around two primary oscillator inputs. These are the 14.7456 MHz input crystal and the 32.768 kHz real time clock oscillator; see Figure 3. The 14.7456 MHz oscillator supplies the main system clock domains for the LH7A404. The 32.768 kHz oscillator controls the power-down operations and real time clock peripheral. The clock and state controller provides the clock gating and frequency division necessary, and then supplies the clocks to the processor and rest of the system. The amount of clock gating that actually takes place depends on the power saving mode selected.

The 32.768 kHz clock provides the source for the Real Time Clock tree and power-down logic. This clock is used for the power state control and is the only clock in the LH7A404 that runs continuously. The 32.768 kHz clock is divided down to 1 Hz for the Real Time Clock counter using a ripple divider to save power.

The 14.7456 MHz source is used to generate the main system clocks for the LH7A404. It is the source for PLL1 and PLL2, the primary clock for the peripherals, and the source clock to the programmable clock (PGM) divider.

PLL1 provides the main clock tree for the chip. It generates the following clocks: FCLK, HCLK, and PCLK. FCLK is the clock that drives the ARM922T core.

HCLK is the main bus (AHB) clock, as such it clocks all memory interfaces, bus arbitrators and the AHB peripherals. HCLK is generated by dividing FCLK by 1, 2, 3, or 4. HCLK can be gated by the system to enable low power operation.

PCLK is the peripheral bus (APB) clock. It is generated by dividing HCLK by either 2, 4, or 8.

PLL2 generates a fixed 48 MHz clock signal for the USB peripheral.

## Power Modes

The LH7A404 has three operational states: Run, Halt, and Standby. During Run all clocks are hardware enabled and the processor is clocked. In the Halt mode the device is functioning, but the processor clock is halted while it waits for an event such as a key press. Standby equates to the computer being switched 'off', i.e. no display (LCD disabled) and the main oscillator is shut down.

## Reset Modes

Three external signals can generate resets to the LH7A404: nPOR (power on reset), nPWRFL (power failure) and nRESET (user reset). If any of these are active, a system reset is internally generated. An nPOR reset performs a full system reset. The nPWRFL and nRESET resets perform a full system reset except for the SDRAM refresh control, SDRAM Global Configuration, SDRAM Device Configuration, and the RTC peripheral registers. The SDRAM controller issues a self-refresh command to external SDRAM before the system enters an nPWRFL and nRESET reset. This allows the system to maintain its Real Time Clock and SDRAM contents. At reset termination, the chip enters Standby mode. Once in the Run mode the PWRSR register can be interrogated to determine the nature of the reset and the trigger source, after which software can then take appropriate actions.

## Data Paths

The data paths in the LH7A404 are:

- The AMBA AHB bus
- The AMBA APB bus
- The External Bus Interface
- The LCD AHB bus
- The DMA busses.

## AMBA AHB BUS

The Advanced Microprocessor Bus Architecture AHB (AMBA AHB) is a high speed 32-bit-wide data bus. The AMBA AHB is for high-performance, high-clock-frequency system modules.

Peripherals with high bandwidth requirements are connected to the LH7A404 core processor using the AHB bus, Boot ROM, Vectored Interrupt Controllers, and USB Device. These include the external and internal memory interfaces, the LCD registers, palette RAM and the bridge to the Advanced Peripheral Bus (APB) interface. The APB Bridge transparently converts the AHB access into the slower speed APB accesses. All control registers for the APB peripherals are programmed using the AHB-to-APB bridge interface. The main AHB data and address lines are configured using a multiplexed bus. This removes the need for tri-state buffers and bus holders and simplifies bus arbitration.

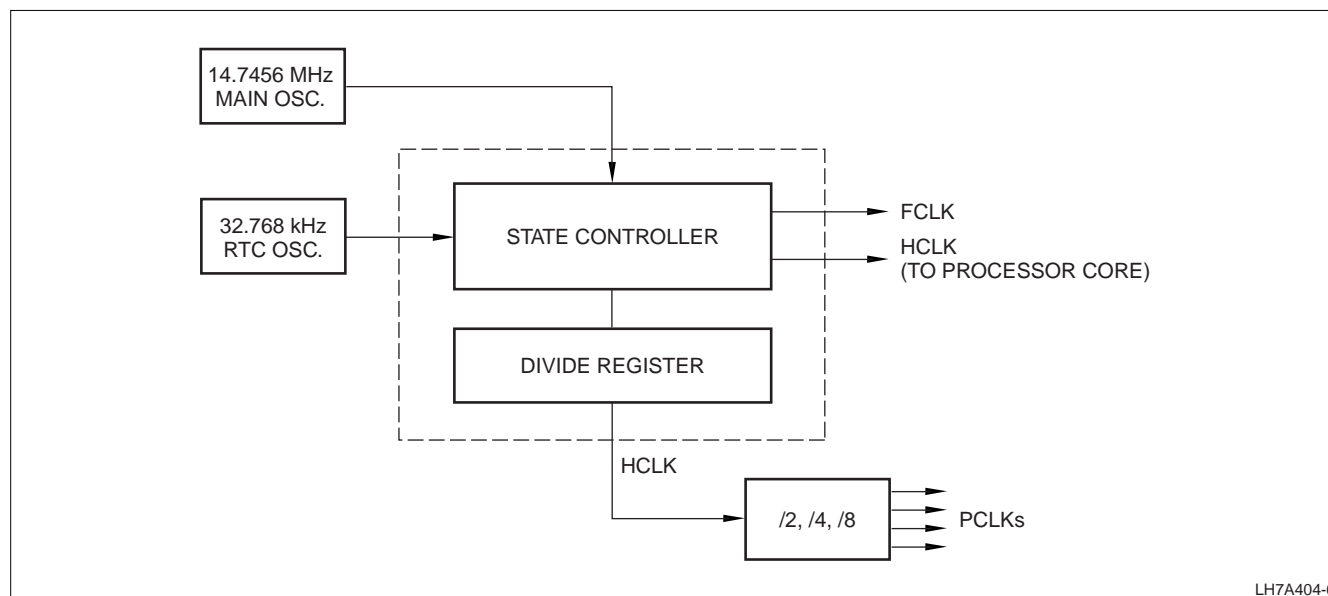


Figure 3. Clock and State Controller Block Diagram

## AMBA APB BUS

The AMBA APB bus is a low speed 32-bit-wide peripheral data bus. The speed of the APB bus is selected by dividing the clock speed of the AHB bus by two, four, or eight.

## EXTERNAL BUS INTERFACE (EBI)

The External Bus Interface (EBI) provides a 32-bit wide, high speed gateway to external memory devices. The supported memory devices include:

- Asynchronous RAM/ROM/Flash
- Synchronous DRAM/Flash
- PCMCIA interfaces
- Compact Flash interfaces.

The EBI can be controlled by either the Asynchronous Memory Controller or Synchronous Memory Controller. There is an arbiter on the EBI input, with priority given to the Synchronous Memory Controller interface.

## LCD BUS

The LCD controller has its own local memory bus that connects it to the system's embedded memory and external SDRAM. The function of this local data bus is to allow the LCD controller to perform its video refresh function without congesting the main AHB bus. This leads to better system performance and lower power consumption. There is an arbiter on both the embedded memory and the synchronous memory controller. In both cases the LCD bus is given priority.

## DMA BUSES

The LH7A404 has a DMA system which connects the higher speed/higher data volume APB peripherals (MMC, USB and AC97) to the AHB bus. This enables the efficient transfer of data between these peripherals and external memory without the intervention of the ARM922T core. The DMA engine does not support memory-to-memory transfers.

## USB HOST CONTROLLER DMA BUS

The USB Host Controller has its own DMA controller. It acts as another bus master on the AHB bus. It does not interact with the non-USB DMA controller except in bus arbitration.

## Memory Map

The LH7A404 system has a 32-bit-wide address bus, allowing addressing up to 4GB of memory. This memory space is subdivided into a number of memory banks, shown in Figure 4. Four of these banks (each 256MB) are allocated to the Synchronous Memory Controller. Eight banks (each 256MB) are allocated to the Asynchronous Memory Controller. Two of these eight banks are designed for PCMCIA systems. Part of the remaining memory space is allocated to the embedded SRAM, and to the control registers of the AHB and APB. The rest of the memory space is not used.

The LH7A404 can boot from either synchronous or asynchronous ROM/Flash. The selection is determined by the value of the MEDCHG pin at power-on reset as shown in Table 4. When booting from synchronous memory, bank 4 (nSCS3) is mapped into memory location zero. When booting from asynchronous memory, memory bank 0 (nSCS0) is mapped into memory location zero.

Figure 4 shows the memory map of the LH7A404 system for the two boot modes.

Once the LH7A404 has booted, the boot code can configure the ARM922T MMU to remap the low memory space to a location in RAM. This allows the user to set the interrupt vector table.

**Table 4. Boot Modes**

BOOT MODES	LATCHED BOOT-WIDTH1	LATCHED BOOT-WIDTH0	LATCHED MEDCHG
8-bit ROM	0	0	0
16-bit ROM	0	1	0
32-bit ROM	1	0	0
32-bit ROM	1	1	0
16-bit SFlash (Initializes Mode Register)	0	0	1
16-bit SROM (Initializes Mode Register)	0	1	1
32-bit SFlash (Initializes Mode Register)	1	0	1
32-bit SROM (Initializes Mode Register)	1	1	1

F000.0000	ASYNC. MEM (nCS0)	SYNC. MEM (nSDCE3)	256MB
E000.0000	SYNC. MEM (nSDCE2)	SYNC. MEM (nSDCE2)	256MB
D000.0000	SYNC. MEM (nSDCE1)	SYNC. MEM (nSDCE1)	256MB
C000.0000	SYNC. MEM (nSDCE0)	SYNC. MEM (nSDCE0)	256 MB
B001.4000	NOT USED	NOT USED	
B000.0000	EMBEDDED SRAM	EMBEDDED SRAM	80KB
8000.3800	NOT USED	NOT USED	
8000.2000	AHB INTERNAL REGISTERS	AHB INTERNAL REGISTERS	
8000.0000	APB INTERNAL REGISTERS	APB INTERNAL REGISTERS	
7000.0000	ASYNC. MEM (nCS7)	ASYNC. MEM (nCS7)	256MB
6000.0000	ASYNC. MEM (nCS6)	ASYNC. MEM (nCS6)	256MB
5000.0000	PCMCIA (SLOT1)	PCMCIA (SLOT1)	256MB
4000.0000	PCMCIA (SLOT0)	PCMCIA (SLOT0)	256MB
3000.0000	ASYNC. MEM (nCS3)	ASYNC. MEM (nCS3)	256MB
2000.0000	ASYNC. MEM (nCS2)	ASYNC. MEM (nCS2)	256MB
1000.0000	ASYNC. MEM (nCS1)	ASYNC. MEM (nCS1)	256MB
0000.0000	SYNC. ROM (nSDCE3)	ASYNC. ROM (nSDCE0)	256MB
	SYNC. MEMORY BOOT	ASYNC. MEMORY BOOT	

LH7A404-7

Figure 4. Memory Mapping for Each Boot Mode

## Vectored Interrupt Controller (VIC)

The LH7A404 VIC controls the interrupts of up to 32 different sources. Two VICs are daisy-chained together to support up to 64 different interrupts. The VIC supports both FIQ and IRQ interrupts. FIQ interrupts have a higher priority than IRQ interrupts. Each VIC can support up to 16 vectored interrupts, for a total of 32 vectored interrupts. If two interrupts with the same priority become active at the same time, the priority must be resolved in software. When an interrupt becomes active, the VIC generates an FIQ or IRQ if the corresponding mask bit is set. No latching of interrupts takes place in the VIC.

After a power-on reset, all mask register bits are cleared, masking all interrupts. The mask bits must be set by software after power-on reset for any interrupts to be enabled.

A vectored interrupt has improved latency as it provides direct information about where its service routine

is located and eliminates software arbitration needed with a simple interrupt controller.

The VICs continue to operate in Halt and Standby modes, so external interrupts may bring the chip out of these low power modes.

## External Bus Interface

The ARM922T, LCD controller, and DMA engine have access to an external memory system. The LCD controller has access to an internal frame buffer in embedded SRAM and an extension buffer in Synchronous Memory for large displays. The processor and DMA engine share the main system bus, providing access to all external memory devices and the embedded SRAM frame buffer.

An arbitration unit ensures that control over the External Bus Interface (EBI) is only granted when an existing access has been completed. See Figure 5.

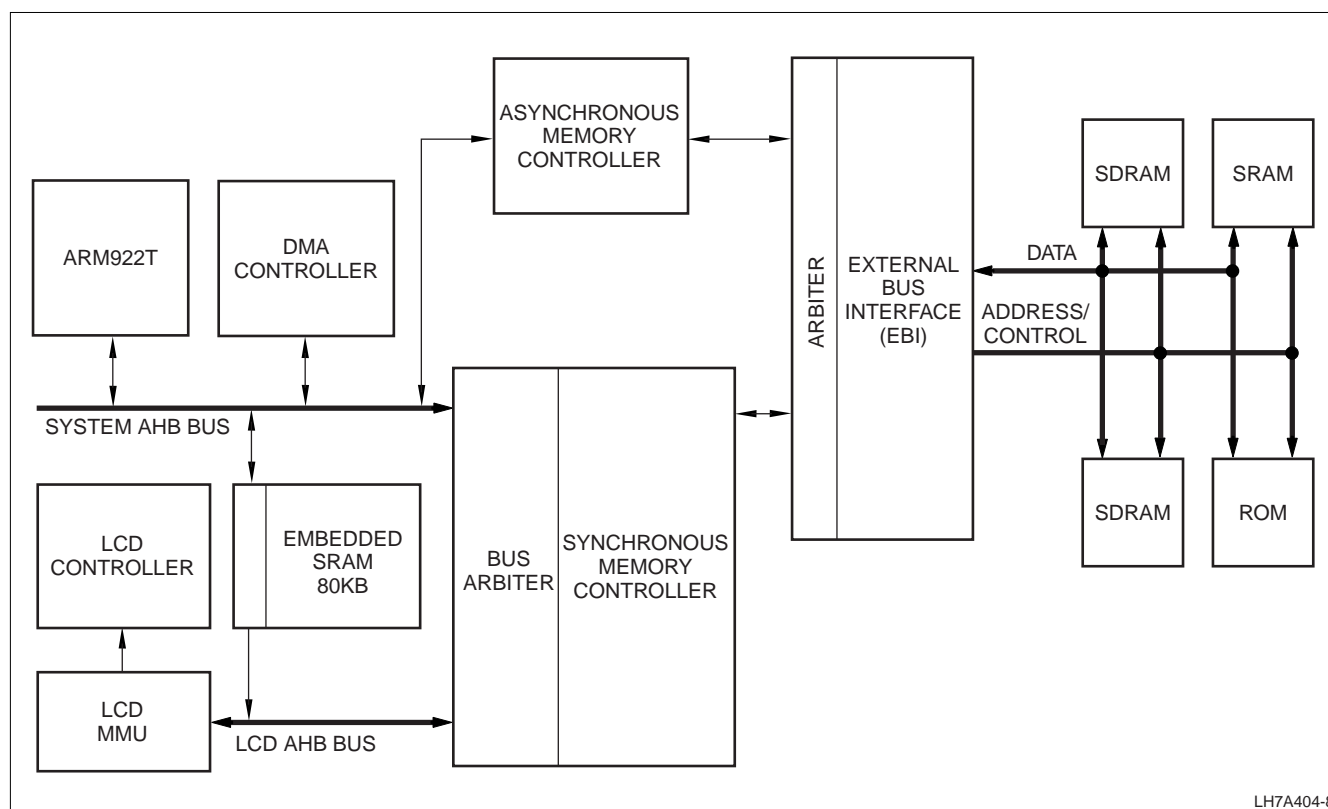


Figure 5. External Bus Interface Block Diagram



## Embedded SRAM

The LH7A404 incorporates 80KB of embedded SRAM. This embedded memory is used for storing code, data, or LCD frame data and is contiguous with external SDRAM. The 80KB is large enough to store a QVGA panel (320 × 240) at 8 bits per pixel, equivalent to 70KB of information.

Locating the frame buffer on chip reduces the overall power consumed by any application that uses the LH7A404. Normally, the system performs external accesses to acquire this data. The LCD controller automatically uses an overflow frame buffer in SDRAM if a larger screen size is required. This overflow buffer can be located on any 4KB page boundary in SDRAM, allowing software to set the MMU (in the LCD controller) page tables such that the two memory areas appear contiguous. Byte, half-word and word accesses are permissible.

## Static Memory Controller (SMC)

The asynchronous Static Memory Controller (SMC) provides an interface between the AMBA AHB system bus and external (off-chip) memory devices.

The SMC simultaneously supports up to eight independently configurable memory banks. Each memory bank can support:

- SRAM
- ROM
- Flash EPROM
- Burst ROM memory.

Each memory bank may use devices using either 8-, 16-, or 32-bit external memory data paths. The memory controller can be configured to support either little-endian or big-endian operation.

The memory banks can be configured to support:

- Non-burst read and write accesses only to high-speed CMOS static RAM
- Non-burst write accesses, nonburst read accesses and asynchronous page mode read accesses to fast-boot block flash memory.

The SMC has six main functions:

- Memory bank select
- Access sequencing
- Wait state generation
- Byte lane write control
- External bus interface
- Compact Flash or PCMCIA interfacing.

## SDRAM (Synchronous) Memory Controller

The SDRAM (Synchronous) Memory Controller provides a high speed memory interface to a wide variety of synchronous memory devices, including Synchronous DRAM, Synchronous Flash and Synchronous ROMs.

The key features of the controller are:

- LCD DMA port for high bandwidth
- Up to four Synchronous Memory banks can be independently set up
- Includes special configuration bits for Synchronous ROM operation
- Includes ability to program Synchronous Flash devices using write and erase commands
- On booting from Synchronous ROM, (and optionally with Synchronous Flash), a configuration sequence is performed before releasing the processor from reset
- Data is transferred between the controller and the Synchronous DRAM in four-word bursts. Longer transfers within the same page are concatenated, forming a seamless burst
- Programmable for 16- or 32-bit data bus size
- Two reset domains enable Synchronous DRAM contents to be preserved over a 'soft' reset
- Power saving Synchronous Memory SCKE and external clock modes provided.

## Secure Digital/MultiMediaCard (MMC)

The SD Memory Card (Secure Digital Memory Card) is a flash-based memory card that meets the security, capacity, performance, and environment requirements inherent in electronic devices. The SD Memory Card host supports MultiMediaCard (MMC) operation as well and is forward compatible. The main difference between SD Card and MMC is the initialization process.

The Secure Digital and MMC adapter can be used as an MMC card or as an SD card and supports the full MMC/SD bus protocol as defined in the MMC system specification 2.11 provided by the MMC Definition Group and the SD Memory Card Spec v1.0 from the SD group. The controller can also implement the SPI interface to the cards.

## SD/MMC INTERFACE DESCRIPTION

The SD/MMC controller uses the three-wire serial data bus (clock, command, and data) to input and output data to and from the MMC card, and to configure and acquire status information from the card's registers. The SD differs only in that it has four data lines.



The SD/MMC bus lines can be divided into three groups:

- Power supply: VSS1, VSS2 and VDD
- Data transfer: MMCCMD, MMCDAT0, MMCDAT1, MMCDAT2, MMCDAT3 (for MMC, do not use MMCDAT1, MMCDAT2, MMCDAT3)
- Clock: MMCCLK

MMC bus lines can be divided into three groups:

- Power supply: VDD and VSS
- Data Transfer: MMCCMD, MMCDATA
- Clock: MMCLK.

### MMC ADAPTER

The MMC Adapter implements MMC specific functions, serves as the bus master for the MMC Bus and implements the standard interface to the MMC Cards (card initialization, CRC generation and validation, command/response transactions, etc.).

### Smart Card Interface (SCI)

The SCI (ISO7816) connects to an external Smart Card reader. The SCI can autonomously control data transfer to and from the smart card. Transmit and receive data FIFOs are provided to reduce the required interaction between the CPU core and the peripheral.

### SCI FEATURES

- Supports asynchronous T0 and T1 transmission protocols
- Supports clock rate conversion factor  $F = 372$ , with bit rate adjustment factors  $D = 1, 2$ , or  $4$  supported
- Eight-character-deep buffered Tx and Rx paths
- Direct interrupts for Tx and Rx FIFO level monitoring
- Interrupt status register
- Hardware-initiated card deactivation sequence on detection of card removal
- Software-initiated card deactivation sequence on transaction complete
- Limited support for synchronous smart cards via registered input/output.

### PROGRAMMABLE PARAMETERS

- Smart card clock frequency
- Communication baud rate
- Protocol convention
- Card activation/deactivation time
- Check for maximum time for first character of Answer to Reset (ATR) reception
- Check for maximum duration of ATR character stream
- Check for maximum time of receipt of first character of data stream
- Check for maximum time allowed between characters
- Character guard time
- Block guard time
- Transmit/receive character retry.

### Direct Memory Access Controller (DMA)

The DMA Controller can be used to interface streams from 20 internal peripherals to the system memory using 10 fully-independent programmable channels which consist of five M2P (transmit) channels and five P2M (receive) channels.

The following peripherals may be allocated to the 10 channels:

- USB Device
- USB Host
- SD/MMC
- AAC
- UART1
- UART2
- UART3

Each of the above peripherals contain one Tx and one Rx channel, except the AAC, which contains three Tx and Rx channels. These peripherals also have their own bi-directional DMA bus, capable of simultaneously transferring data in both directions. All memory transfers take place via the main system AHB bus.

The DMA Controller can also be used to interface streams from memory-to-memory (M2M) or memory-to-external peripheral (M2P) using two dedicated M2M channels. External handshake signals are available to support memory-to-/from-external peripheral (M2P/P2M) transfers. A software trigger is available for M2M transfers only.

The DMA features:

- Two dedicated channels for M2M and external M2P/P2M
- Ten fully independent, programmable DMA controller internal M2P/P2M channels (5 Tx and 5 Rx)
- Channels assignable to one of a number of different peripherals
- Independent source and destination address registers. Source and destination can be programmed to auto-increment or not auto-increment for M2M channels
- Two buffer descriptors per M2P and M2M channel to avoid potential data under/over-flow due to software introduced latency. A buffer refers to the area in system memory that is characterized by a buffer descriptor, i.e., a start address and the length of the buffer in bytes
- No AMBA wrapping bursts for DMA channels; only incrementing bursts are supported
- Buffer size independent of the peripheral's packet size for the internal M2P channels. Transfers can automatically switch between buffers
- Maskable interrupt generation
- Internal arbitration between DMA channels, plus support for an AHB bus arbiter
- DMA data transfer sizes, byte, word and quad-word data transfers are supported using a 16-byte data bay. Maximum data transfer size per M2M channel is programmable
- Per-channel clock gating reducing power in channels that have not been enabled by software. See the 'Clock and State Controller' section.

A set of control and status registers are available to the system processor for setting up DMA operations and monitoring their status. System interrupts are generated when any/all of the DMA channels wish to inform the processor to update the buffer descriptor. The DMA controller can service 10 out of 20 possible peripherals using the ten DMA channels, each with its own peripheral DMA bus capable of simultaneously transferring data in both directions.

The SD/MMC, UART1/2/3, USB Device, and USB Host peripherals can each use two DMA channels, one for transmit and one for receive. The AAC peripheral can use six DMA channels (three transmit and three receive) to allow different sample frequency data queues to be handled with low software overheads.

The DMA controller includes an M2M transfer feature allowing block moves of data from one memory address space to another with minimum of program effort and time. An M2M software trigger capability is provided. The DMA controller can also fill a block of memory with data from a single location.

The DMA controller's M2M channels can also be used in M2P/P2M mode. A set of external handshake signals, DREQ, DACK and TC/DEOT are provided for each of two M2M channels.

DREQ (input) can be programmed edge or level active, and active HIGH or LOW. The peripheral may hold DREQ active for the duration of the block transfers or may assert/deassert on each transfer.

DACK (output) can be programmed active HIGH or LOW. DACK will assert and return to de-asserted with each Read or Write, the timing coinciding with nOE or nWE from the EBI.

TC/DEOT is a bidirectional signal with programmable direction and active polarity. When configured as an Output, the DMA will assert Terminal Count (TC) on the final transfer to coincide with the DACK, typically when the byte count has expired. When configured as an Input, the peripheral must assert DEOT concurrent with DREQ for the final transfer in the block.

Transfer is terminated when DEOT is asserted by the external peripheral or when the byte count expires, whichever occurs first. Status bits indicate if the actual byte count is equal to the programmed limit, and if the count was terminated by peripheral asserting DEOT. Terminating the transfer causes a DMA interrupt on that channel and rollover to the 'other' buffer if so configured.

For byte- or word-wide peripherals, the DMA is programmed to request byte- or word-wide AHB transfers respectively. The DMA does not issue an AHB HREQ for a transfer until it has DREQ asserted after a DACK for the previous transfer; and the previous transfer has been asserted for the duration of the programmed wait states in the SMC (and possibly DREQ is sampled in the cycle DACK is deasserted).

## USB Device

The features of the USB are:

- Fully compliant to USB 1.1 specification
- Provides a high-level interface that shields the firmware from USB protocol details
- Compatible with both OpenHCI and Intel UHCI standards
- Supports full-speed (12 Mbps) functions
- Supports Suspend and Resume signalling.

## USB Host Controller

The features of the USB Host Controller are:

- Open Host Controller Interface Specification (Open-HCI) Rev. 1.0 compatible
- Universal Serial Bus Specification Rev. 1.1 compatible
- Support for both Low Speed and High Speed USB devices
- Root Hub has two Downstream Ports
- DMA functionality.

## Color LCD Controller

The LH7A404's LCD Controller is programmable to support up to 1,024 × 768, 16-bit color LCD panels. It interfaces directly to STN, color STN, TFT, and HR-TFT panels. Unlike other LCD controllers, the LH7A404's LCD Controller incorporates the timing conversion logic from TFT to HR-TFT, allowing a direct interface to HR-TFT and minimizing external chip count.

The Color LCD Controller features support for:

- Up to 1,024 × 768 Resolution
- 16-bit Video Bus
- STN, Color STN, HR-TFT, TFT panels
- Single and Dual Scan STN panels
- Up to 15 Gray Shades
- Up to 64 k-Colors

## Advanced Audio Codec (AAC)

The Advanced Audio Codec controller (AC97) includes a 5-pin serial interface to an external audio codec. The AAC link is a bi-directional, fixed rate, serial Pulse Code Modulation (PCM) digital stream, dividing each audio frame into 12 outgoing and 12 incoming data streams (slots), each with 20-bit sample resolution.

The AAC controller contains logic that controls the AAC link to the audio codec and an interface to the AMBA APB.

Its main features include:

- Serial-to-parallel conversion for data received from the external codec
- Parallel-to-serial conversion for data transmitted to the external codec
- Reception/transmission of control and status information via the AMBA APB interface

- Support for up to 4 different codec sampling rates at a time with its 4 transmit and 4 receive channels. The transmit and receive paths are buffered with internal FIFO memories, allowing data to be stored independently in both transmit and receive modes. The outgoing data for the FIFOs can be written via either the APB interface or with DMA channels 1-3.

## Audio Codec Interface (ACI)

The ACI provides:

- A digital serial interface to an off-chip 8-bit codec
- All the necessary clocks and timing pulses to perform serialization or de-serialization of the data stream to or from the codec device.

The interface supports full duplex operation and the transmit and receive paths are buffered with internal FIFO memories allowing up to 16 bytes to be stored independently in both transmit and receive modes.

The ACI includes a programmable frequency divider that generates a common transmit and receive bit clock output from the on-chip ACI clock input (ACICLK). Transmit data values are output synchronous with the rising edge of the bit clock output. Receive data values are sampled on the falling edge of the bit clock output. The start of a data frame is indicated by a synchronization output signal that is coincident with the bit clock.

## Pulse Width Modulator (PWM)

The Pulse Width Modulator features:

- Configurable dual output
- Separate input clocks for each PWM output
- 16-bit resolution
- Programmable synchronous mode support
  - Allows external input to start PWM
- Programmable pulse width (duty cycle), interval (frequency), and polarity
  - Static programming: when the PWM is stopped
  - Dynamic programming: when the PWM is running
  - Updates duty cycle, frequency, and polarity at end of a PWM cycle

The PWM is a configurable dual-output, dual-clock-input AMBA slave module, and connects to the APB.

## Synchronous Serial Port (SSP)

The SSP is a master-only interface for synchronous serial communication with peripheral devices that have either Motorola SPI, National Semiconductor MICROWIRE, or Texas Instruments Synchronous Serial Interfaces.

The SSP performs serial-to-parallel conversion on data received from a peripheral device. The transmit and receive paths are buffered with internal FIFO memories allowing up to eight 16-bit values to be stored independently in both transmit and receive modes. Serial data is transmitted on SSPTXD and received on SSPRXD.

The LH7A404 SSP includes a programmable bit rate clock divider and prescaler to generate the serial output clock SCLK from the input clock SSPCLK. Bit rates are supported to 2 MHz and beyond, subject to choice of frequency for SSPCLK; the maximum bit rate will usually be determined by peripheral device's capability.

## UART/IrDA

The LH7A404 contains three UARTs; UART1, UART2, and UART3.

The UART performs:

- Serial-to-Parallel conversion on data received from the peripheral device
- Parallel-to-Serial conversion on data transmitted to the peripheral device.

The transmit and receive paths can both be routed through the DMA separately or simultaneously, and are buffered with internal FIFO memories. This allows up to 16 bytes to be stored independently in both transmit and receive modes.

The UART can generate:

- Four individually maskable interrupts from the receive, transmit and modem status logic blocks
- A single combined interrupt so that the output is asserted if any of the individual interrupts are asserted and unmasked.

If a framing, parity or break error occurs during reception, the appropriate error bit is set and stored in the FIFO. If an overrun condition occurs, the overrun register bit is set immediately and the FIFO data is prevented from being overwritten. UART1 also supports IrDA 1.0 (15.2 kbit/s).

The modem status input signals Clear to Send (CTS), Data Carrier Detect (DCD) and Data Set Ready (DSR) are supported on UART2 and UART3.

## Timers

The LH7A404 includes three programmable timers. Each of the timers can operate in two modes: free running and pre-scale. The timers are programmed using four registers; Load, Value, Control, and Clear.

Two identical timers, Timer 1 (TC1) and Timer 2 (TC2), use clock sources of either 508 kHz or 2 kHz. The clock source and mode is selectable by writing to the appropriate bits in the system control register. Each timer has a 16-bit read/write data register and a control register. The timer is loaded with the value written to the data register immediately. This value is then decremented on the next active clock edge to arrive after the write. When the timer underflows, it immediately asserts its appropriate interrupt.

Timer 3 (TC3) has the same basic operation, but is clocked from a single 7.3728 MHz source. Once the timer has been enabled and written to, it decrements on the next rising edge of the 7.3728 MHz clock after the data register has been updated.

### FREE-RUNNING MODE

In free-running mode, the timer wraps around to 0xFFFF when it underflows and continues counting down.

### PRE-SCALE MODE

In pre-scale (periodic) mode, the value written to each timer is automatically re-loaded when the timer underflows. This mode can be used to produce a programmable frequency to drive the buzzer or generate a periodic interrupt.

## Real Time Clock (RTC)

The RTC provides a basic alarm function or long time-base counter. This is achieved by generating an interrupt signal after counting for a programmed number of cycles of a real-time clock input. Counting in one second intervals is achieved by use of a 1 Hz clock input to the RTC.

## Keyboard and Mouse Interface (KMI)

The Keyboard and Mouse Interface has the following features:

- IBM PS2 or AT-compatible keyboard or mouse interface
- Half-duplex bidirectional synchronous serial interface using open-drain outputs for clock and data.
- Programmable 4-bit reference clock divider
- Polled or interrupt-driven mode
- Separately maskable transmit and receive interrupts
- Single combined interrupt output
- Odd parity generation and checking
- Register bits for override of keyboard clock and data lines.

Additional test registers and modes are implemented for functional verification and manufacturing test.

## Touch Screen Controller (TSC)

The Touch Screen Controller is a complete interface to a touch screen as used in portable personal devices. It combines the front-end biasing and control circuitry with analog-to-digital conversion, reference generation, and digital control and interface functions to completely replace external ICs used to implement this interface. The features are:

- 10-bit A/D converter with integrated sample-and-hold, fully differential, high impedance signal and reference inputs.
- Input active matrix for bias and control circuits necessary for connection to external 4- and 5-wire touch sensitive panels.
- Auxiliary functions such as temperature sense, pen pressure sense, battery voltage sense, in addition to normal direct voltage inputs.
- A 10-channel multiplexer for routing user-selected inputs to A/D
- 16 × 16 FIFO for 10-bit digital output of A/D
- Pen down sensor to generate interrupts to the host
- Low power circuitry and power control modes to minimize in-system power dissipation.
- Conversion automation to maximize flexibility while minimizing CPU management and interrupt overhead
- Supply voltage 3.0 V - 3.6 V
- Configurable input pads so that when an Analog input is not being used, the pad can be used as a GPIO.

## Battery Monitor Interface (BMI)

The BMI is a serial communication interface specified for two types of battery monitors/gas gauges. The first type employs a single wire interface. The second interface employs a two-wire multi-master bus, the Smart Battery System Specification. If both interfaces are enabled at the same time, the Single Wire Interface will have priority.

### SINGLE WIRE INTERFACE

The Single Wire Interface performs:

- Serial-to-parallel conversion on data received from the peripheral device
- Parallel-to-serial conversion on data transmitted to the peripheral device
- Data packet coding/decoding on data transfers (incorporating Start/Data/Stop data packets)

The Single Wire interface uses a command-based protocol in which the host initiates a data transfer by sending a WriteData/Command word to the battery monitor. This word always contains the command section, which tells the Single Wire Interface device the location for the current transaction. The most significant bit of the command determines if the transaction is Read or Write. In the case of a Write transaction the word will also contain a WriteData section with the data to be written to the peripheral.

### SMART BATTERY INTERFACE

The Smart Battery Interface performs:

- Serial-to-parallel conversion on data received from the peripheral device
- Parallel-to-serial conversion of data transmitted to the peripheral device.

The Smart Battery Interface uses a two-wire multi-master bus (the SMBus), allowing multiple bus masters to be connected to it. A master device initiates a bus transfer and provides the clock signals. A slave device can receive data provided by the master or it can provide data to the master. Since more than one device may attempt to take control of the bus as a master, SMBus provides an arbitration mechanism by relying on the wired-AND connection of all SMBus interfaces to the SMBus.



## DC-to-DC Converter

The features of the DC-DC Converter interface are:

- Dual drive PWM outputs with independent closed loop feedback
- Software programmable configuration of one of 8 output frequencies (each being a fixed division of the input clock).
- Software programmable configuration of duty cycle from 0 to 15/16, in intervals of 1/16.
- Hardware-configured output polarity (for positive or negative voltage generation) during power-on reset via the polarity select inputs
- Dynamically switched PWM outputs to one of a pair of preprogrammed frequency/duty cycle combinations via external pins.

## Watchdog Timer (WDT)

The Watchdog Timer provides hardware protection against malfunctions. It is a programmable timer that is reset by software at regular intervals. Failure to reset the timer will cause an FIQ interrupt. Failure to service the FIQ interrupt generates a system reset. Features of the WDT:

- Timing derived from the system clock
- 16 programmable time-out periods:  $2^{16}$  through  $2^{31}$  clock cycles
- Generates a system reset (resets LH7A404) or a FIQ interrupt whenever a time-out period is reached
- Software enable, lockout, and counter-reset mechanisms add security against inadvertent writes
- Protection mechanism guards against interrupt-service-failure:
  - The first WDT time-out triggers FIQ and asserts nWDFIQ status flag
  - If FIQ service routine fails to clear nWDFIQ, then the next WDT time-out triggers a system reset.

## General Purpose I/O (GPIO)

The GPIO has eight ports, each with a data register and a data direction register. It also has added registers including Keyboard Scan, PINMUX, GPIO Interrupt Enable, INTYPE1/2, GPIOFEOI and PGHCON.

The data direction register determines whether a port is configured as an input or an output while the data register is used to read the value of the GPIO pins.

The GPIO Interrupt Enable, INTYPE1/2, and the GPIOFEOI registers control edge-triggered Interrupts on Port F. The PINMUX register controls which signals are from Port D and Port E when they are set as outputs, while the PGHCON controls the operations of Port G and Port H.

## ELECTRICAL SPECIFICATIONS

### Absolute Maximum Ratings

PARAMETER	MINIMUM	MAXIMUM
DC Core Supply Voltage (VDDC)	- 0.3 V	2.4 V
DC I/O Supply Voltage (VDD)	- 0.3 V	4.6 V
DC Analog Supply Voltage (VDDA1, VDDA2)	- 0.3 V	2.4 V
DC Analog Supply Voltage (VDDA3)	- 0.3 V	4.6 V
Storage Temperature	-55°C	125°C

**NOTE:** These stress ratings are only for transient conditions. Operation at or beyond absolute maximum rating conditions may affect reliability and cause permanent damage to the device.

### Recommended Operating Conditions

PARAMETER	MINIMUM	TYPICAL	MAXIMUM	NOTES
DC Core Supply Voltage (VDDC)	1.62 V	1.8 V	1.98 V	1
DC I/O Supply Voltage (VDD)	1.62 V	3.3 V	3.6 V	7
DC Analog Supply Voltage (VDDA1, VDDA2)	1.62 V	1.8 V	1.98 V	
DC Analog Supply Voltage (VDDA3)	3.0 V	3.3 V	3.6 V	
Clock Frequency	10 MHz		200 MHz	2, 3, 4, 5
Commercial Operating Temperature	0°C	25°C	+70°C	
Industrial Operating Temperature	-40°C	25°C	+85°C	6

**NOTES:**

1. Core Voltage should never exceed I/O Voltage.
2. Using 14.756 MHz Main Oscillator Crystal and 32.768 kHz RTC Oscillator Crystal.
3. Commercial Temperature Range.
4. VDDC = 1.62 V to 1.98 V.
5. VDD = 3.0 V to 3.6 V.
6. With Clock Frequency Reduction. The LH7A404 has not yet been characterized for the Industrial Temperature Range.
7. Using the LH7A404 below VDD = 3.0 V will affect the AC timing and the USB will not function. AC timing for VDD less than 3.0 V has not yet been characterized.

## DC/AC SPECIFICATIONS (COMMERCIAL)

Unless otherwise noted, all data provided under commercial DC/AC specifications are based on 0°C to +70°C, VDDC = 1.62 V to 1.98 V, VDD = 3.3 V to 3.6 V, VDDA1 and VDDA2 = 1.62 V to 1.98 V; VDDA3 = 3.0 to 3.6 V.

### DC Specifications

SYMBOL	PARAMETER	MIN.	MAX.	UNIT	CONDITIONS	NOTES
VIH	CMOS and Schmitt Trigger Input HIGH Voltage	2.0		V		
VIL	CMOS and Schmitt Trigger Input LOW Voltage		0.8	V		
VHST	Schmitt Trigger Hysteresis	0.35		V	VIL to VIH	
VOH	CMOS Output HIGH Voltage, Output Drive 1	2.6	3.6	V	IOH = 2 mA	
	Output Drive 2	2.6	3.6	V	IOH = 4 mA	
	Output Drive 3	2.6	3.6	V	IOH = 8 mA	
	Output Drive 4 and 5	2.6	3.6	V	IOH = 16 mA	1
VOL	CMOS Output LOW Voltage, Output Drive 1	0.0	0.4	V	IOL = 2 mA	
	Output Drive 2	0.0	0.4	V	IOL = 4 mA	
	Output Drive 3	0.0	0.4	V	IOL = 8 mA	
	Output Drive 4	0.0	0.4	V	IOL = 16 mA	
	Output Drive 5	0.0	0.4	V	IOL = 24 mA	1
IIN	Input Leakage Current	-10	10	μA	VIN = VDD or GND	
IOZ	Output Tri-state Leakage Current	-10	10	μA	VOUT = VDD or GND	
IACTIVE	Active Current (Operating Current)		180	mA		
IHALT	Halt Current		6.0	mA		2
ISTANDBY	Standby Current		20	μA		3
ISTARTUP	Startup Current		50	μA		4
CIN	Input Capacitance		4	pF		
COUT	Output Capacitance		4	pF		

#### NOTES:

1. Output Drive 5 can sink 24 mA of current, but sources 16 mA of current.
2. Both oscillators running, LCD Active; all other peripherals stopped.
3. 32 kHz oscillator running; all other peripherals stopped.
4. Current consumption until oscillators are stabilized.

### AC Test Conditions

PARAMETER	RATING	UNIT
DC I/O Supply Voltage (VDD)	3.0 to 3.6	V
DC Core Supply Voltage (VDDC)	1.62 to 1.98	V
Input Pulse Levels	VSS to 3	V
Input Rise and Fall Times	2	ns
Input and Output Timing Reference Levels	VDD/2	V



## AC Specifications (Commercial)

All signals described in Table 5 relate to transitions following a reference clock signal. The illustration in Figure 6 represents all cases of these sets of measurement parameters.

The reference clock signals in this design are:

- HCLK, the System Bus internal clock
- PCLK, the Peripheral Bus clock
- SSPCLK, the Synchronous Serial Port clock
- UARTCLK, the UART Interface clock
- LCDDCLK, the LCD Data clock from the LCD Controller
- AC97CLK, the AC97 clock
- SCLK, the Synchronous Memory clock.

All signal transitions are measured from the 50% point of the clock to the 50% point of the signal.

For outputs from the LH7A404, tOVXXX (e.g. tOVA) represents the amount of time for the output to become valid from the rising edge of the reference clock signal. Maximum requirements for tOVXXX are shown in Table 5.

The signal tOHXXX (e.g. tOHA) represents the amount of time the output will be held valid following the rising edge of the reference clock signal. Minimum requirements for tOHXXX are listed in Table 5.

For inputs, tISXXX (e.g. tISD) represents the amount of time the input signal must be valid before the rising edge of the clock signal. Minimum requirements for tISXXX are shown in Table 5.

The signal tIHXXX (e.g. tIHD) represents the amount of time the output must be held valid following the rising edge of the reference clock signal. Minimum requirements are shown in Table 5.

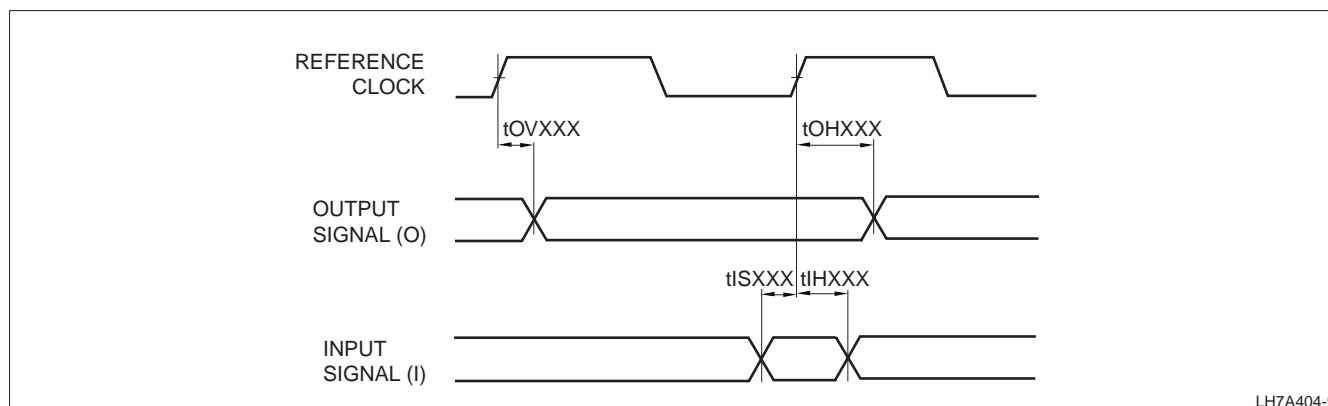


Figure 6. LH7A404 Signal Timing

Table 5. AC Signal Characteristics

SIGNAL	TYPE	LOAD	DRIVE	SYMBOL	MIN.	MAX.	DESCRIPTION
<b>ASYNCHRONOUS MEMORY INTERFACE SIGNALS</b>							
A[27:0]	Output	50 pF	8 mA	tOVA		8 ns	Address Valid
				tOHA	0 ns		Address Hold
D[31:0]	Output	50 pF	8 mA	tOVD		6 ns	Data Valid
				tOHD	2 ns		Data Hold
	Input			tISD	2 ns		Data Setup
				tIHD	0 ns		Data Hold
nCS[7:0]	Output	30 pF	8 mA	tOVCS		8 ns	Chip Select Valid
				tOHCS	0 ns		Chip Select Hold
nWE[3:0]	Output	30 pF	8 mA	tOVWE		8 ns	Write Enable Valid
				tOHWE	0 ns		Write Enable Hold
nBLE[3:0]	Output	30 pF	8 mA	tOVBLE		8 ns	Byte Lane Enable Valid
				tOHBLE	0 ns		Byte Lane Enable Hold
nOE	Output	30 pF	8 mA	tOVOE		8 ns	Ouput Enable Valid
				tOHOE	0 ns		Ouput Enable Hold

Table 5. AC Signal Characteristics (Cont'd)

SIGNAL	TYPE	LOAD	DRIVE	SYMBOL	MIN.	MAX.	DESCRIPTION
SYNCHRONOUS MEMORY INTERFACE SIGNALS							
A[15:2]/SA[13:0]	Output	50 pF	8 mA	tOVA		8 ns	Address Valid
A[17:16]/SBANK[1:0]	Output	50 pF	8 mA	tOVb		8 ns	Address Valid/Bank Select Valid
D[31:0]	Output	50 pF	8 mA	tOVD	2 ns	6 ns	Data Valid
	Input			tISD	4 ns		Data Setup
				tIHD	0 ns		Data Hold
nCAS	Output	30 pF	8 mA	tOVCA	2 ns	6 ns	CAS Valid
				tOHCA	0 ns		CAS Hold
nRAS	Output	30 pF	8 mA	tOVRA	2 ns	6 ns	RAS Valid
				tOHRA	0 ns		RAS Hold
nSWE	Output	30 pF	8 mA	tOVSDW	2 ns	6 ns	Write Enable Valid
				tOHSDW	0 ns		Write Enable Hold
SCKE[1:0]	Output	30 pF	8 mA	tOVC0	2 ns	6 ns	Clock Enable Valid
DQM[3:0]	Output	30 pF	8 mA	tOVDQ	2 ns	6 ns	Data Mask Valid
nSCS[3:0]	Output	30 pF	8 mA	tOVSC	2 ns	6 ns	Synchronous Chip Select Valid
				tOVHSC	0 ns		Synchronous Chip Select Hold
PC CARD (PCMCIA) INTERFACE SIGNALS							
A[25:0]	Output	50 pF	8 mA	tOVA		8 ns	Address Valid
nCFREG	Output	30 pF	8 mA	tOVDREG	2 ns	8 ns	nREG Valid
				tOHDREG	0 ns		nREG Hold
D[31:0]	Input			tISD	4 ns		Data Setup Time
				tIHD	0 ns		Data Hold Time
nCFCE1	Output	30 pF	8 mA	tOVCE1	0 ns	8 ns	Chip Enable 1 Valid
				tOHCE1	0 ns		Chip Enable 1 Hold
nCFCE2	Output	30 pF	8 mA	tOVCE2	0 ns	8 ns	Chip Enable 2 Valid
				tOHCE2	0 ns		Chip Enable 2 Hold
nCFOE	Output	30 pF	8 mA	tOVOE	0 ns	8 ns	Output Enable Valid
				tOHOE	0 ns		Output Enable Hold
nCFWE	Output	30 pF	8 mA	tOVWE	0 ns	8 ns	Write Enable Valid
				tOHWE	0 ns		Write Enable Hold
MMC INTERFACE SIGNALS							
MMCCMD	Output	100 pF	8 mA	tOVCMD		TBD	MMC Command Valid
				tOHCMD	TBD		MMC Command Hold
MMCDATA	Output	100 pF	8 mA	tOVDAT		TBD	MMC Data Valid
				tOHDAT	TBD		MMC Data Hold
MMCDATA	Input			tISDAT	TBD		MMC Data Setup
				tIHDAT	TBD		MMC Data Hold
MMCCMD	Input			tOVCMD	TBD		MMC Command Setup
				tIHCMD	TBD		MMC Command Hold
AC97 INTERFACE SIGNALS							
AC97OUT	Output	30 pF	8 mA	tOVAC97		TBD	AC97 Output Valid
				tOHAC97	TBD		AC97 Output Hold
AC97IN	Input			tISAC97	TBD		AC97 Input Setup
				tIHAC97	TBD		AC97 Input Hold
SYNCHRONOUS SERIAL PORT (SSP)							
SSPFRM	Input			tISSPFRM	14 ns		SSPFRM Input Valid
SSPTX	Output	50 pF	2 mA	tOVSSPOUT	TBD		SSP Transmit Valid
SSPRX	Input			tISSPIN	14 ns		SSP Receive Setup

**NOTES:**

1. TBD = To Be Determined, awaiting characterization.
2. For Output Drive strength specifications, refer to 'DC Specifications'.



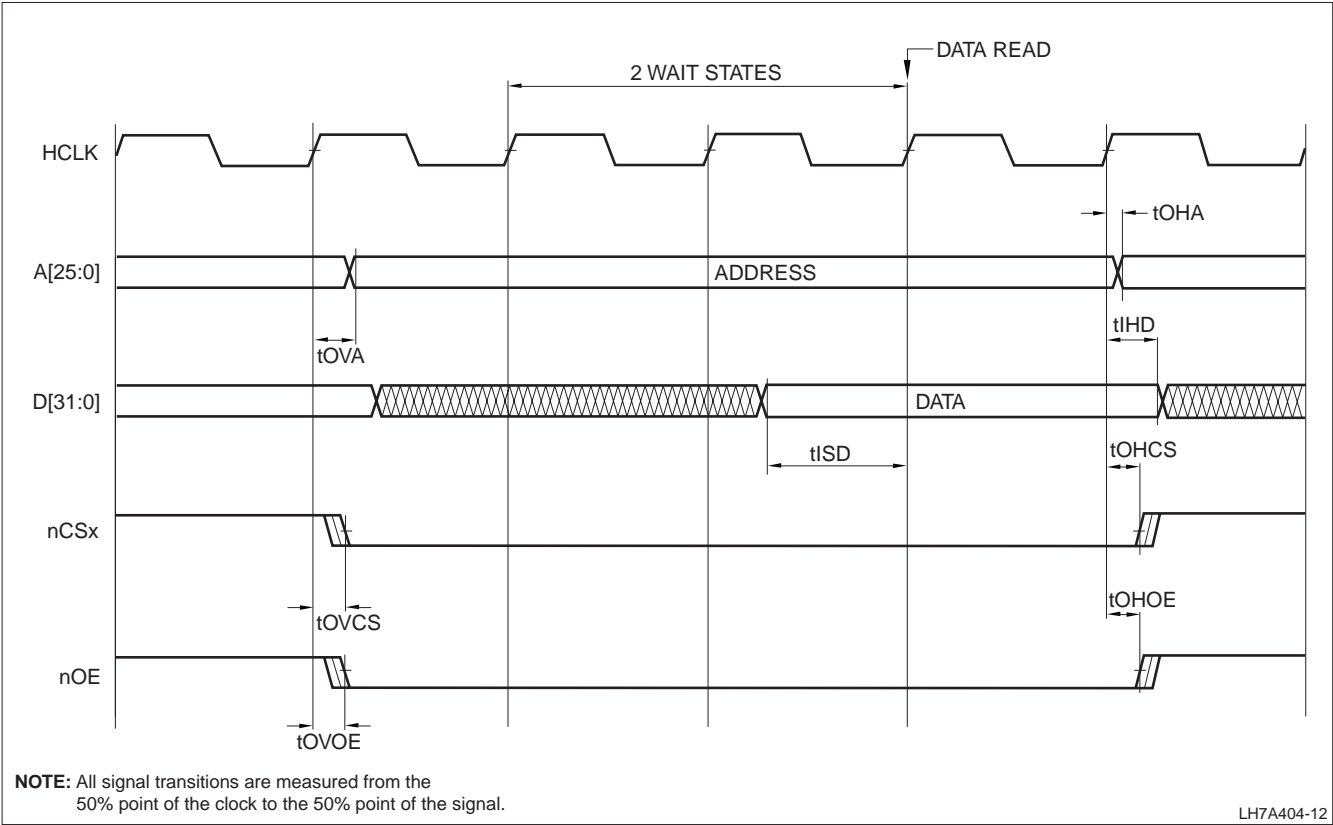


Figure 9. External Asynchronous Memory Read, Two Wait States

## Synchronous Memory Controller Waveforms

Figure 10 shows the waveform and timing for a Synchronous Burst Read (page already open). Figure 11 shows the waveform and timing for synchronous memory to activate a bank and Write.

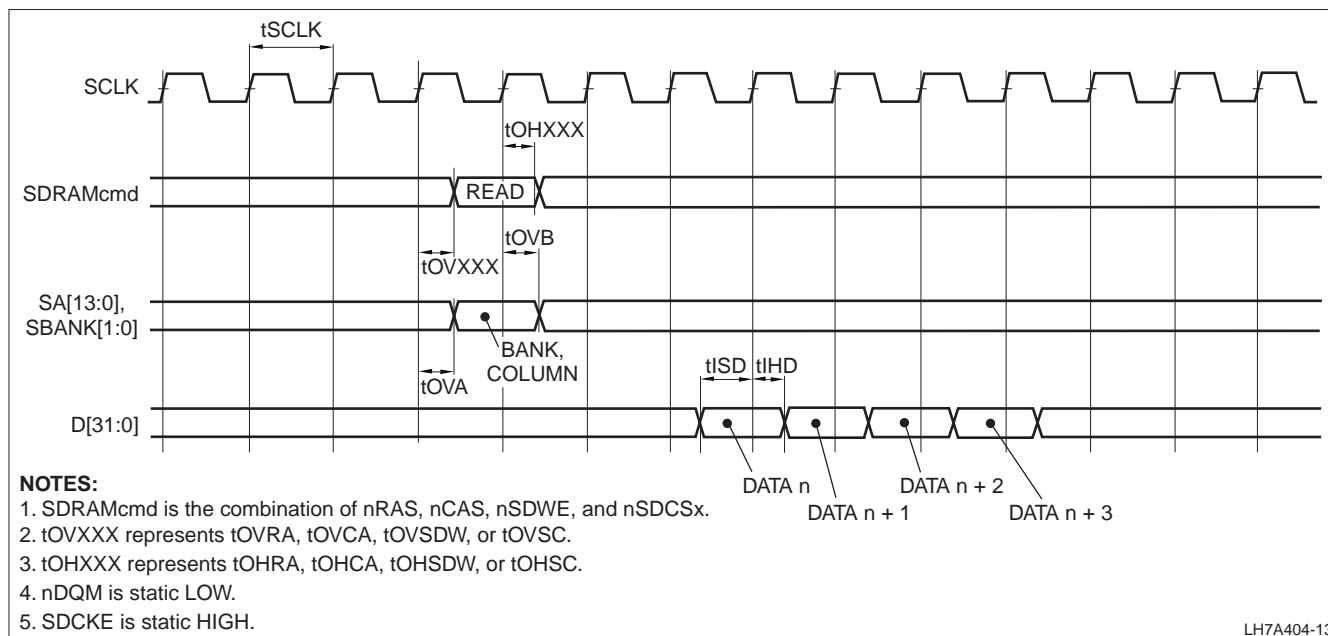


Figure 10. Synchronous Burst Read

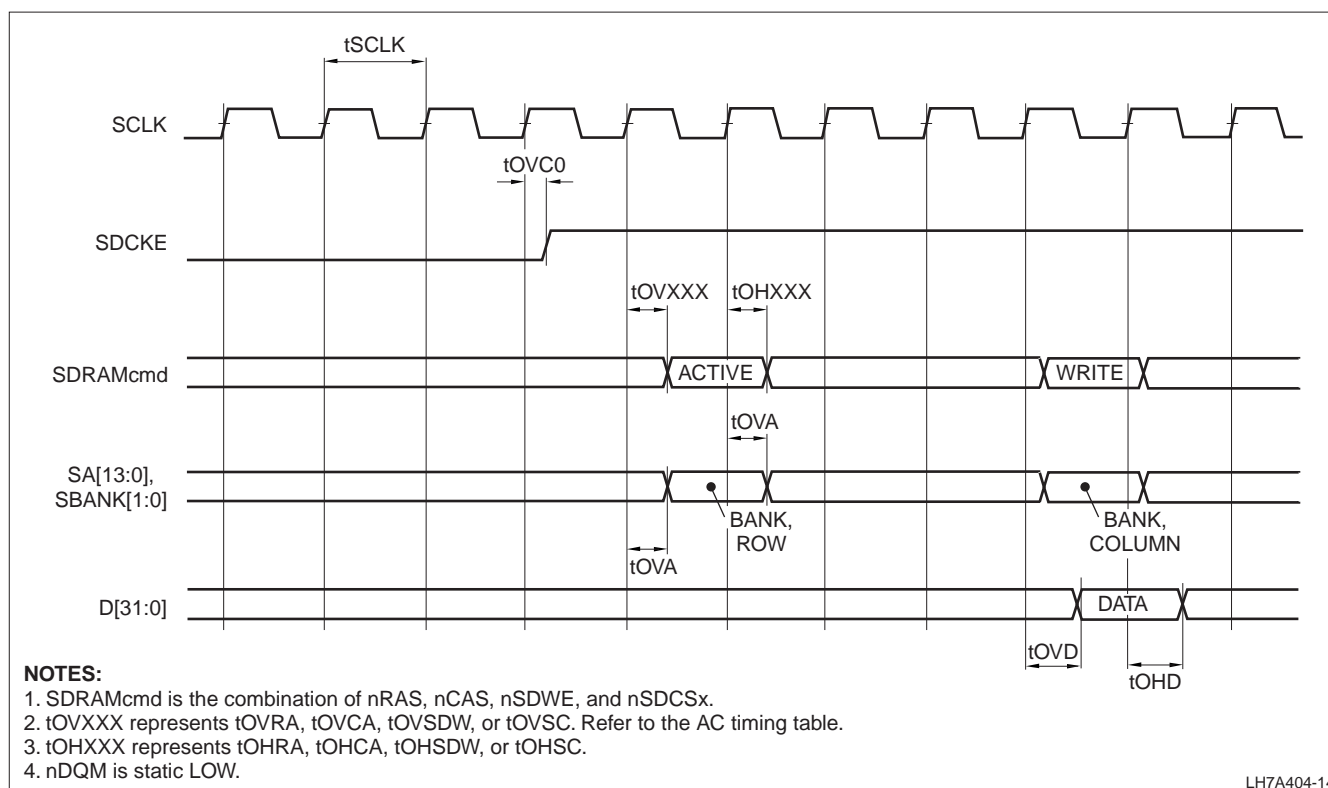


Figure 11. Synchronous Bank Activate and Write

## SSP Waveforms

The Synchronous Serial Port (SSP) supports three data frame formats:

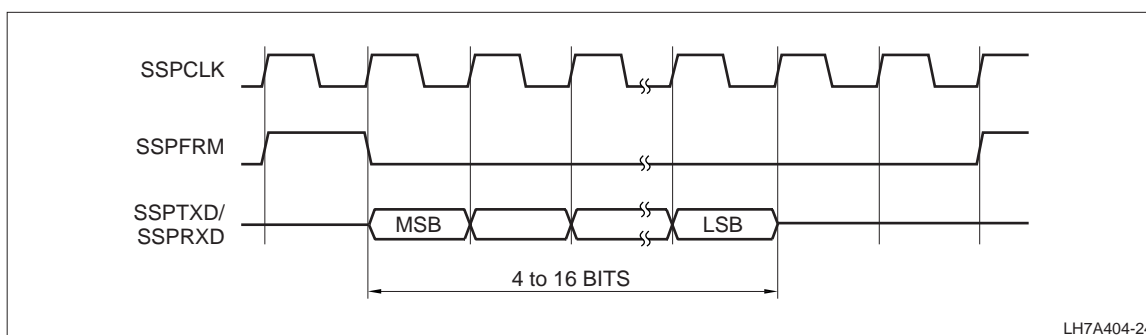
- Texas Instruments' synchronous serial
- Motorola SPI
- National Semiconductor MICROWIRE

Each frame format is between 4 and 16 bits in length, depending upon the programmed data size. Each data frame is transmitted beginning with the Most Significant Bit (MSB) i.e. 'big endian'. For all three formats, the SSP serial clock is held LOW (inactive) while the SSP is idle. The SSP serial clock transitions only during active transmission of data. The SSPFRM signal marks the beginning and end of a frame. The

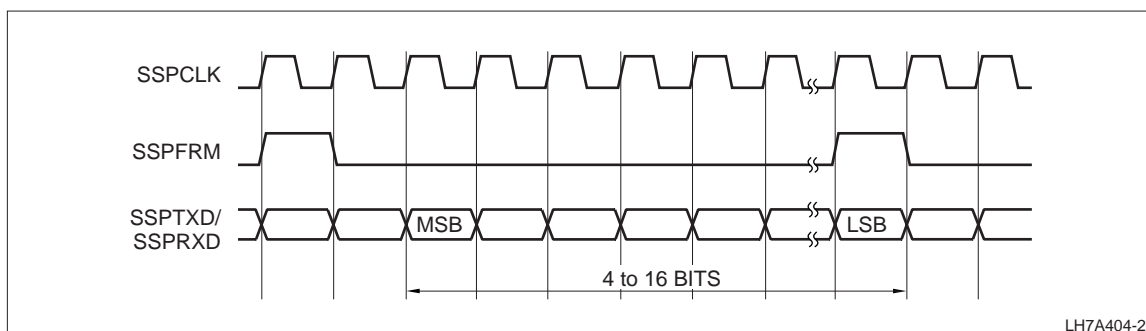
SSPEN signal controls an off-chip line driver's output enable pin.

Figure 12 and Figure 13 show Texas Instruments synchronous serial frame format, Figure 14 through Figure 21 show the Motorola SPI format, and Figure 22 and Figure 23 show National Conductor's MICRO-WIRE data frame format.

For Texas Instruments' synchronous serial frame format, the SSPFRM pin is pulsed prior to each frame's transmission for one serial clock period beginning at its rising edge. For this frame format, both the SSP and the external slave device drive their output data on the rising edge of the clock and latch data from the other device on the falling edge. See Figure 12 and Figure 13.



**Figure 12. Texas Instruments Synchronous Serial Frame Format (Single Transfer)**



**Figure 13. Texas Instruments Synchronous Serial Frame Format (Continuous Transfer)**

For Motorola SPI format, the serial frame pin (SSP-FRM) is active LOW. The SPO and SPH bits in SSP Control Register 0 determine SSPCLK and SSPFRM

operation in single and continuous modes. See Figures 14 through 21.

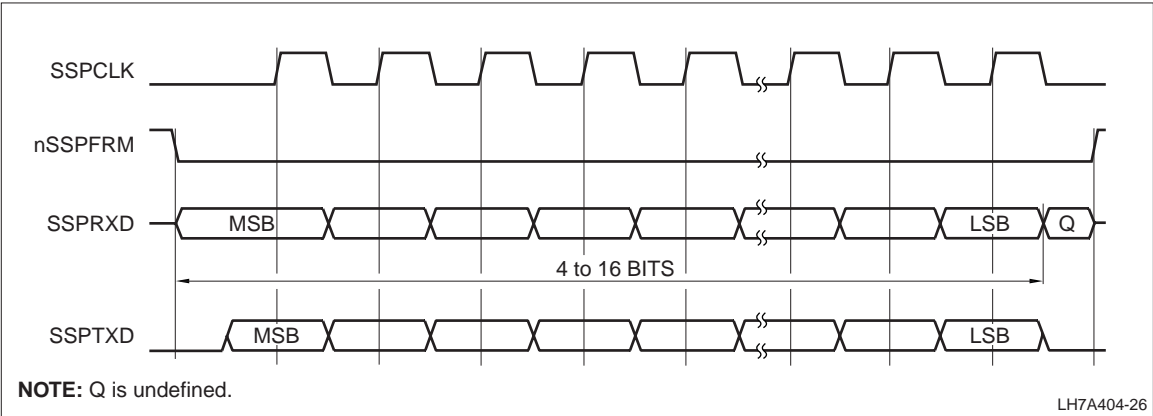


Figure 14. Motorola SPI Frame Format (Single Transfer) with SPO = 0 and SPH = 0

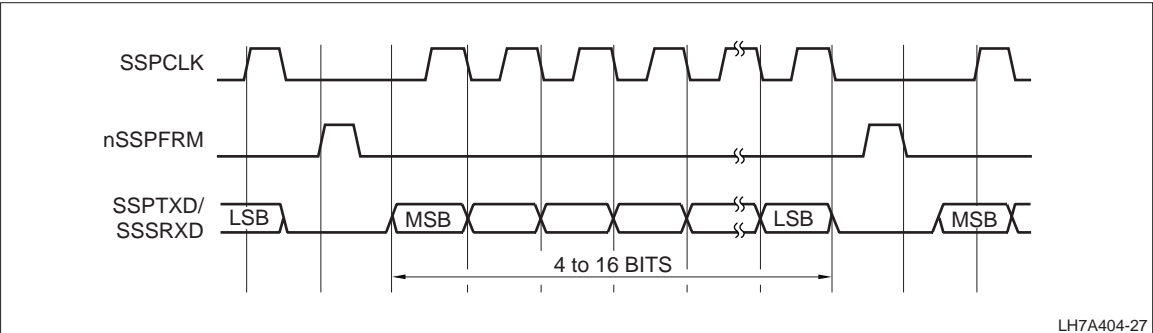


Figure 15. Motorola SPI Frame Format (Continuous Transfer) with SPO = 0 and SPH = 0

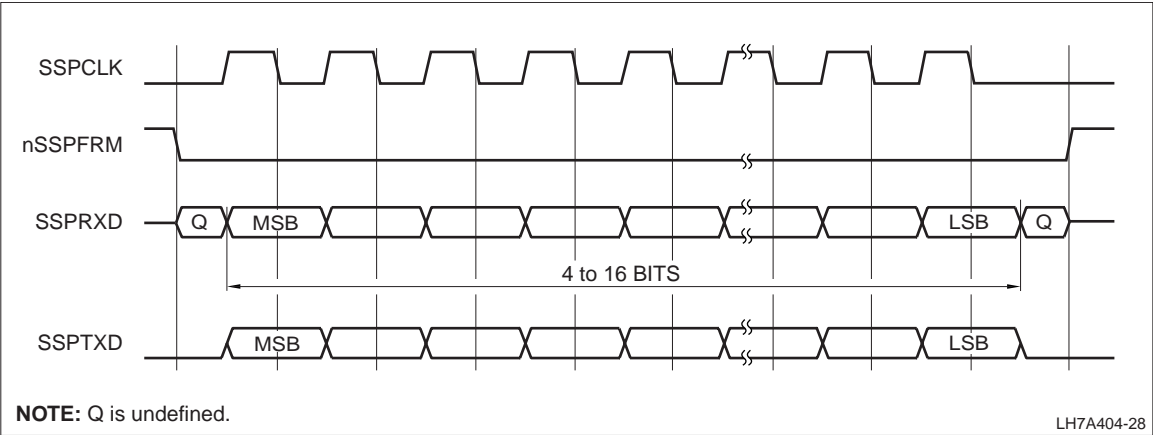


Figure 16. Motorola SPI Frame Format (Single Transfer) with SPO = 0 and SPH = 1

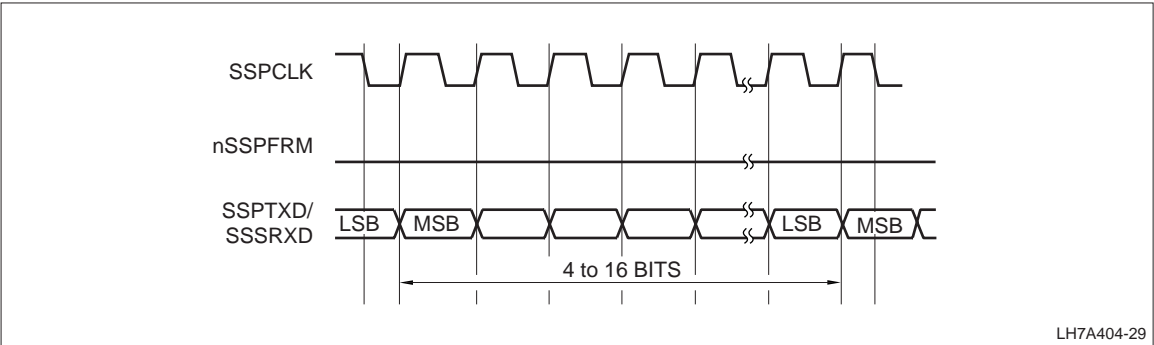


Figure 17. Motorola SPI Frame Format (Continuous Transfer) with SPO = 0 and SPH = 1

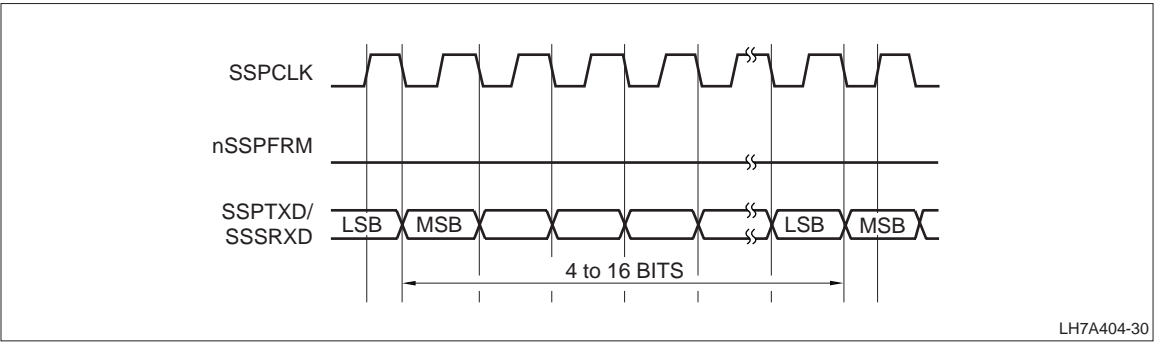


Figure 18. Motorola SPI Frame Format (Continuous Transfer) with SPO = 1 and SPH = 1

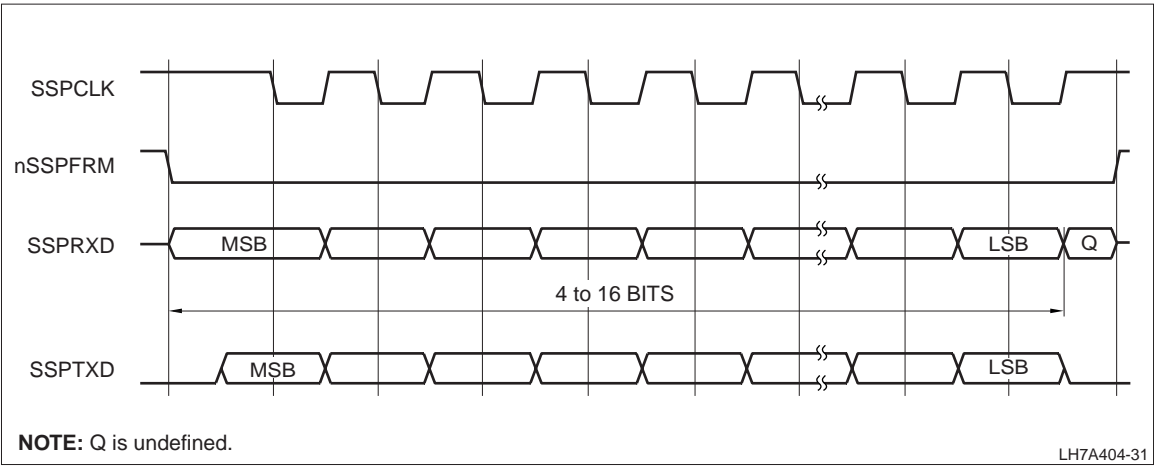


Figure 19. Motorola SPI Frame Format (Single Transfer) with SPO = 1 and SPH = 0



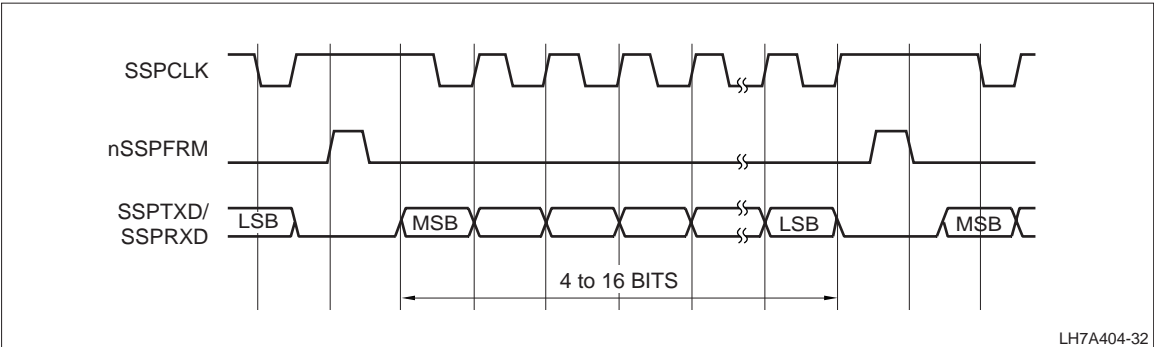


Figure 20. Motorola SPI Frame Format (Continuous Transfer) with SPO = 1 and SPH = 0

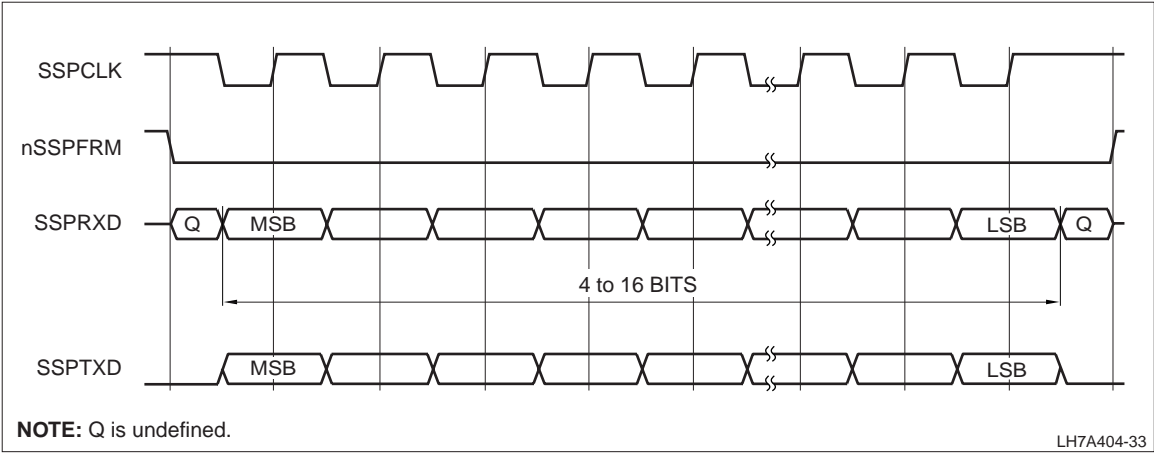


Figure 21. Motorola SPI Frame Format (Single Transfer) with SPO = 1 and SPH = 1

For National Semiconductor MICROWIRE format, the serial frame pin (SSPFRM) is active LOW. Both the SSP and external slave device drive their output data on the falling edge of the clock, and latch data from the other device on the rising edge of the clock. Unlike the full-duplex transmission of the other two frame formats, the National Semiconductor MICROWIRE format utilizes a master-slave messaging technique that operates in half-duplex. When a frame begins in this mode,

an 8-bit control message is transmitted to the off-chip slave. During this transmission no incoming data is received by the SSP. After the message has been sent, the external slave device decodes the message. After waiting one serial clock period after the last bit of the 8-bit control message was received it responds by returning the requested data. The returned data can be 4 to 16 bits in length, making the total frame length between 13 to 25 bits. See Figure 22 and Figure 23.

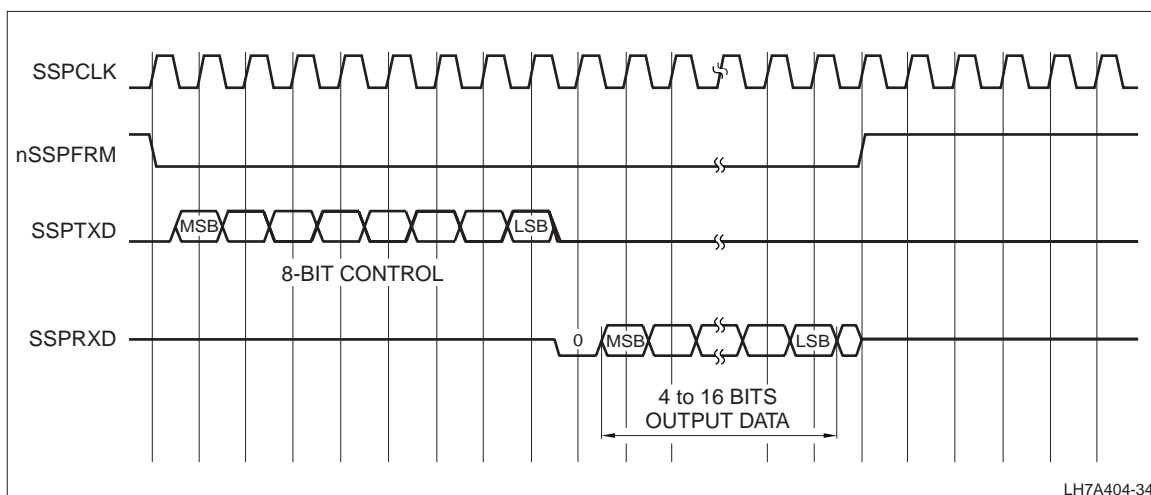


Figure 22. MICROWIRE Frame Format (Single Transfer)

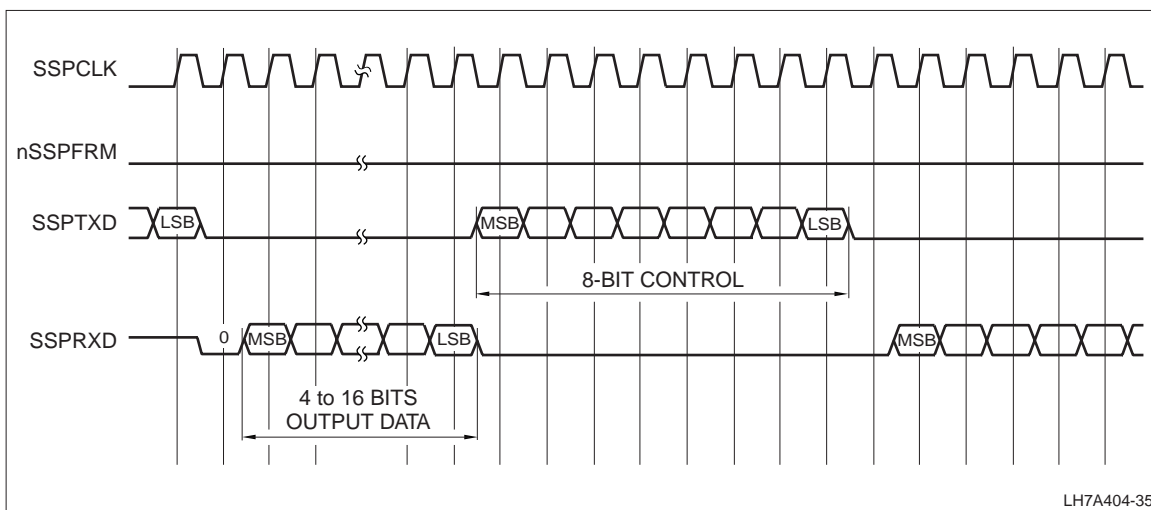


Figure 23. MICROWIRE Frame Format (Continuous Transfers)

## PC Card (PCMCIA) Waveforms

Figure 24 shows the waveforms and timing for a PCMCIA attribute memory Read transfer, Figure 25 shows the waveforms and timing for a PCMCIA attribute

memory Write transfer, Figure 26 shows the waveforms and timing for a PCMCIA common memory Read transfer, and Figure 27 shows the waveforms and timing for a PCMCIA common memory Write transfer.

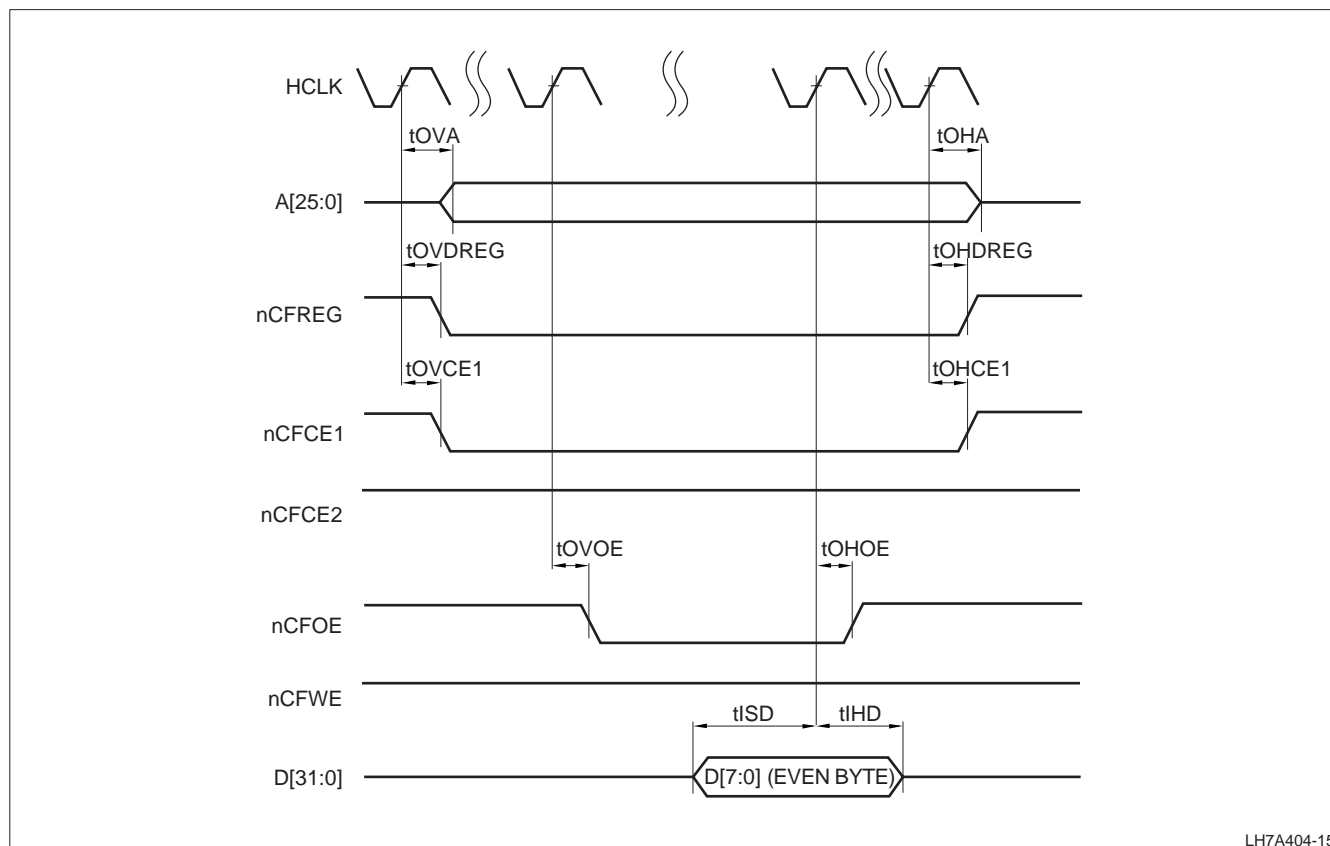
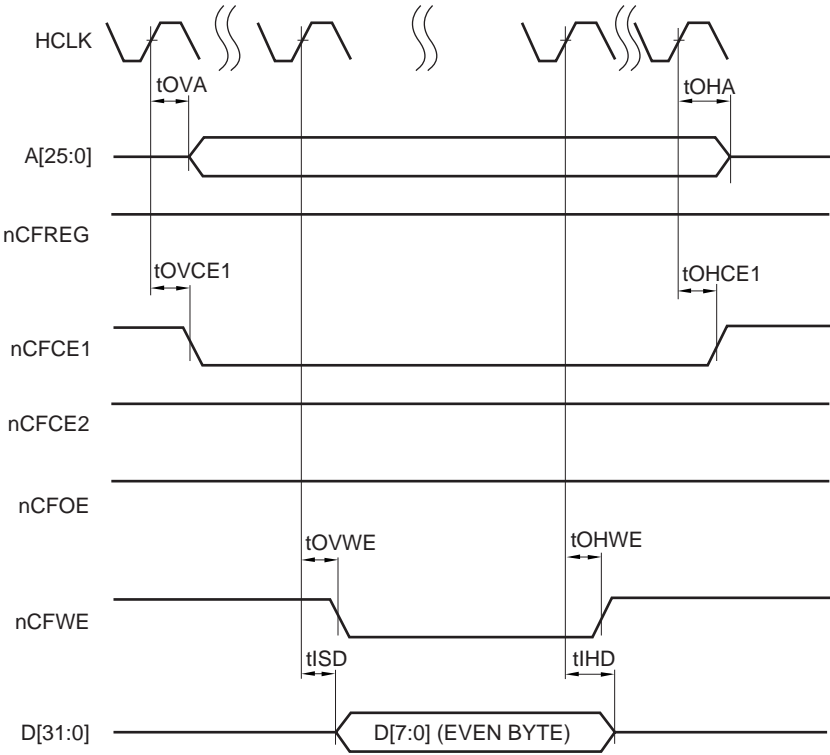
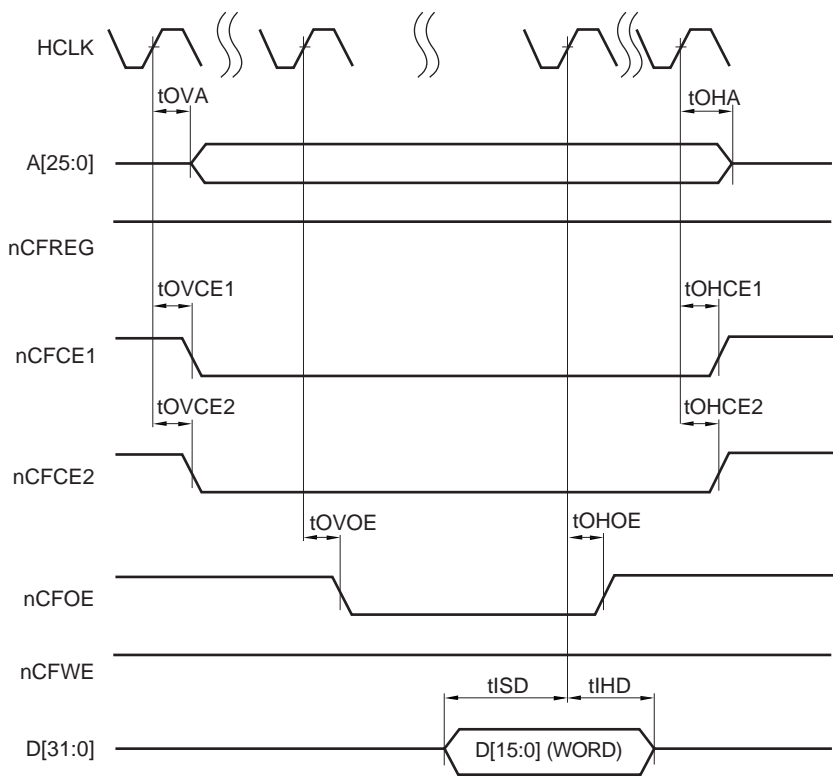


Figure 24. PCMCIA Attribute Memory Read Transfer



LH7A404-16

Figure 25. PCMCIA Attribute Memory Write Transfer



LH7A404-17

Figure 26. PCMCIA Common Memory Read Transfer

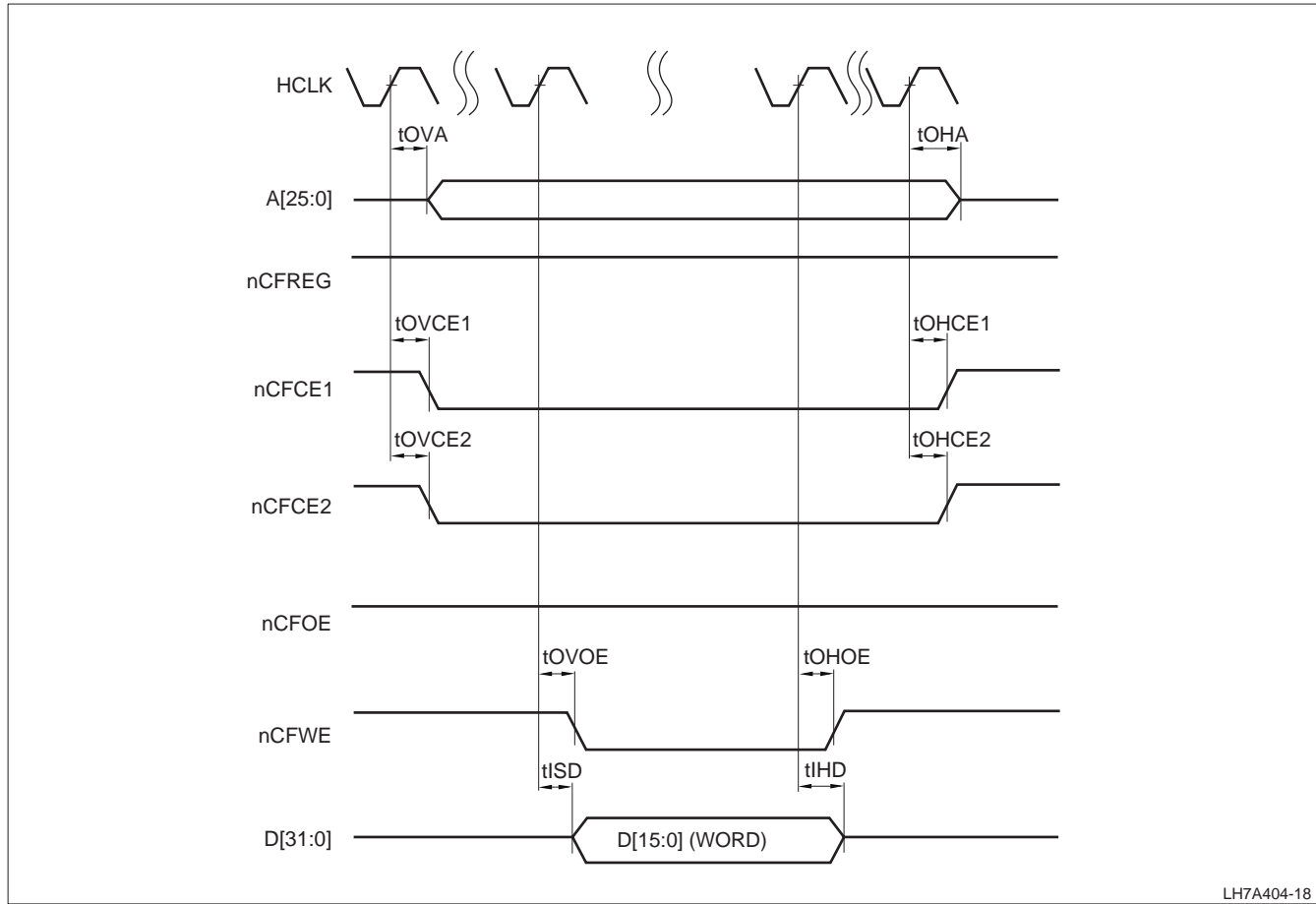


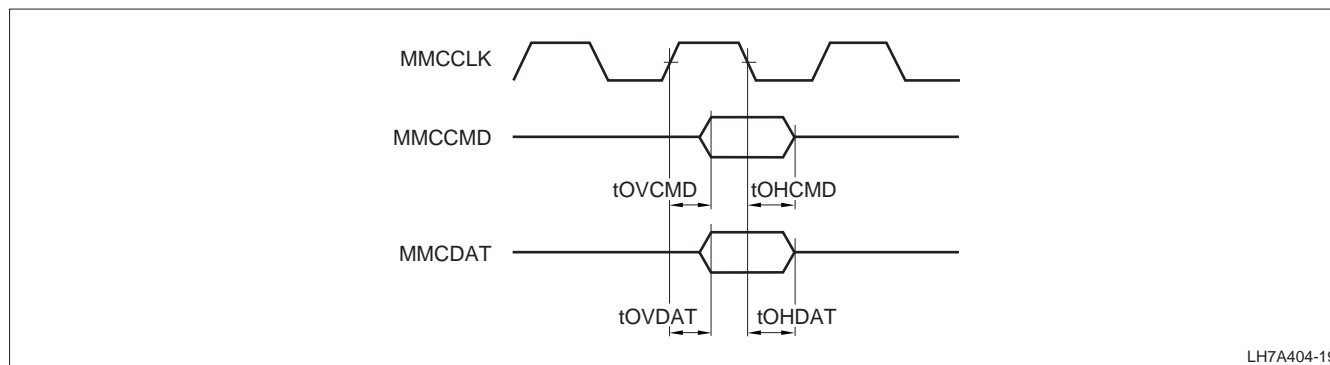
Figure 27. PCMCIA Common Memory Write Transfer

## MMC Interface Waveforms

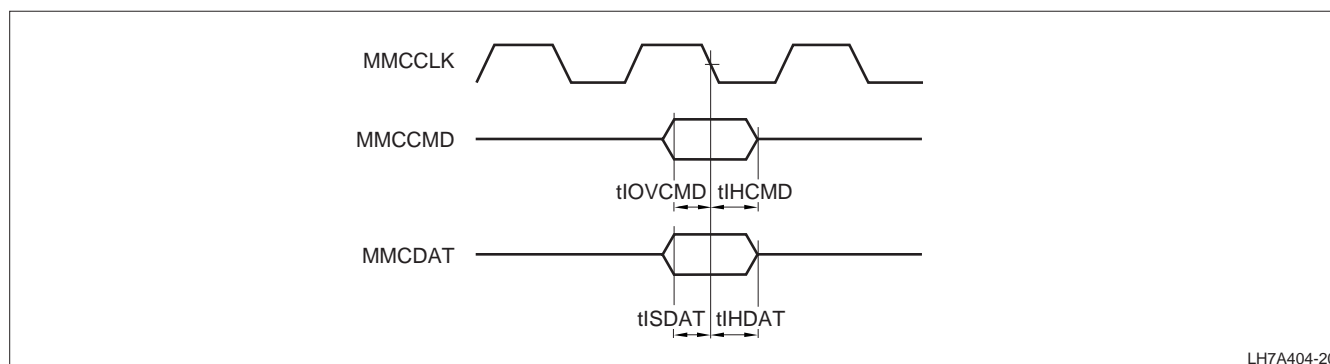
Figure 28 shows the waveforms and timing for an MMC command or data Write. Figure 29 shows the waveforms and timing for an MMC command or data Read.

## AC97 Interface Waveforms

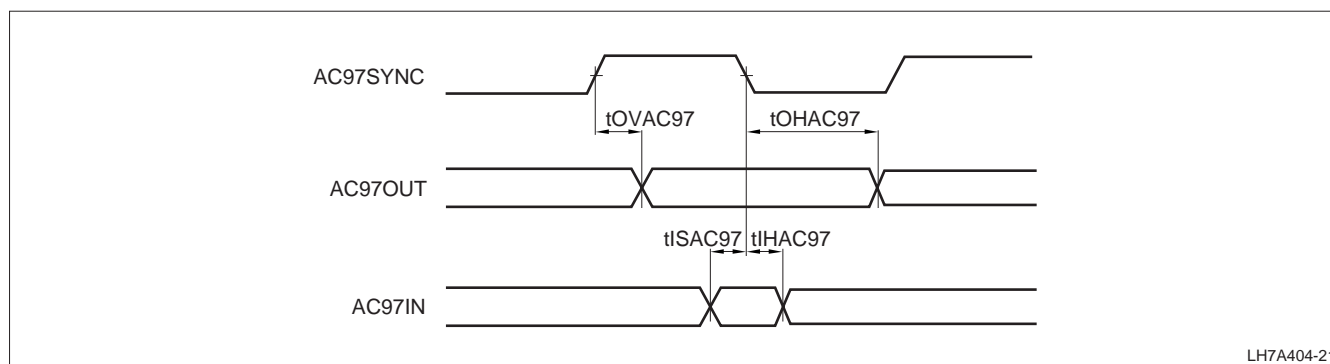
Figure 30 shows the waveforms and timing for the AC97 interface Data Setup and Hold.



**Figure 28. MMC Command/Data Write**



**Figure 29. MMC Command/Data Read**



**Figure 30. AC97 Data Setup and Hold**

Reset, Clock, and Power Controller  
(RCPC) Waveforms

Figure 31 shows the behavior of the LH7A404 when coming out of Reset or Power-On. Figure 32 shows external reset timing, and Table 6 gives the timing parameters.

Table 6. Reset AC Timing

PARAMETER	DESCRIPTION	MIN.	TYP.	MAX.	UNIT
tOSC (32 kHz)	Oscillator stabilization time after Power Up (VDDC = VDDCMIN)			550	ms
tOSC (14 MHz)	Oscillator stabilization time after Power Up (VDDC = VDDCMIN)			2.5	ms
tRSTIW	nRESETIN Pulse Width (once sampled LOW)	2			HCLK
tRSTOV	nRESETIN LOW to nRESETOUT valid (once nRESETIN sampled LOW)		3.5		HCLK
tRSTOH	nRESETOUT hold relative to nRESETIN HIGH		1		HCLK

NOTE: \*VDDC = VDDCmin

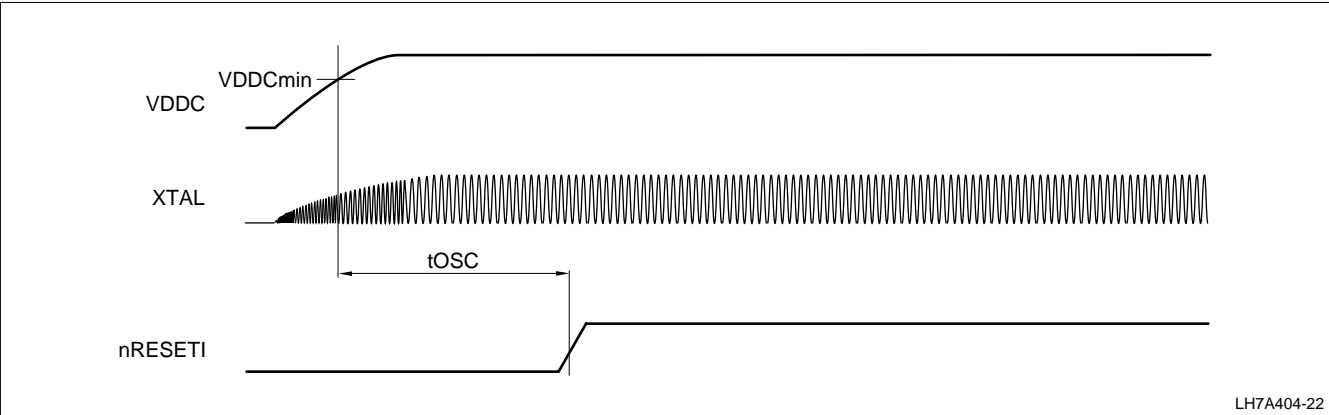


Figure 31. PLL Start-up

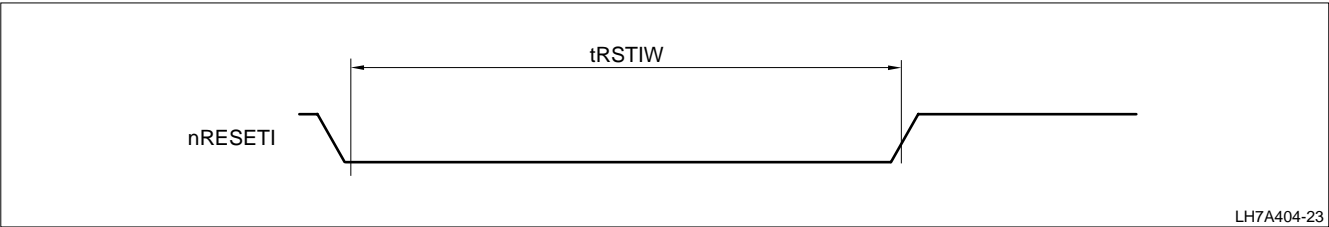


Figure 32. External Reset



**DC/AC SPECIFICATIONS (INDUSTRIAL)**

To be determined.

PACKAGE SPECIFICATIONS

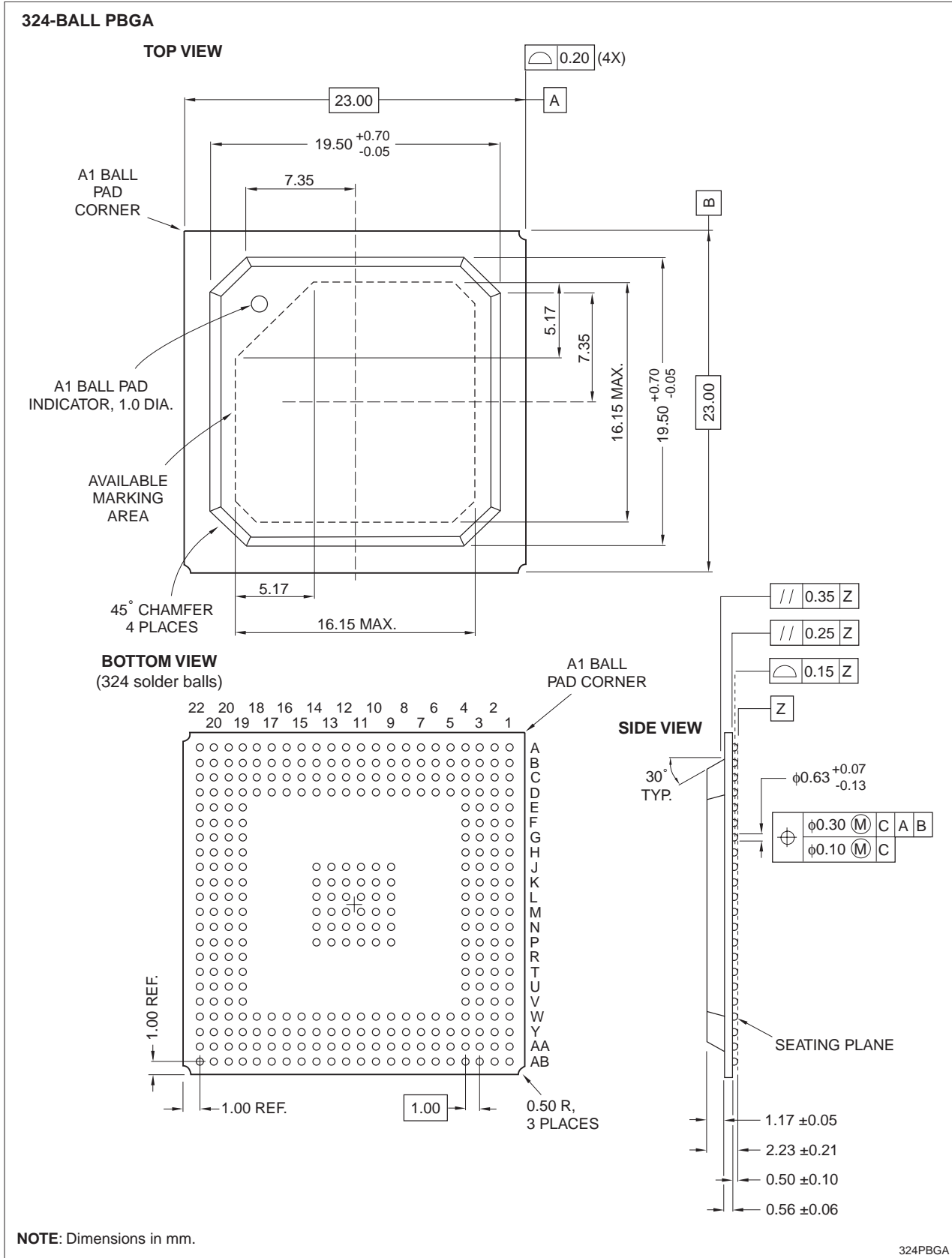


Figure 33. 324-Ball PBGA Package Specification

**SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.**

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