68040 FEATURES

- Selection of Processor Speeds: 25, 33MHz
- Military Temperature Range: - 55°C to +125°C
- Packaging
  - 179 pin Ceramic PGA (P4)
  - 184 lead Ceramic Quad Flatpack, CQFP (Q4)
- 6-Stage Pipeline, 68030-Compatible IU
- 68881/68882-Compatible FPU
- Independent Instruction and Data MMUs
- Simultaneously Accessible, 4-Kbyte Physical Instruction Cache and 4-Kbyte Physical Data Cache
- Low-Latency Bus Acceses for Reduced Cache Miss Penalty
- Multimaster/Multiprocessor Support via Bus Snooping
- Concurrent IU, FPU, MMU, and Bus Controller Operation Maximizes Throughput
- 32-Bit, Nonmultiplexed External Address and Data Buses with Synchronous Interface
- User Object-Code Compatible with all Earlier 68000 Microprocessors
- 4-GigaByte Direct Addressing Range

DESCRIPTION

The WC32P040 is a 68000-compatible, high-performance, 32-bit microprocessor. The WC32P040 is a virtual memory microprocessor employing multiple concurrent execution units and a highly intergrated architecture that provides very high performance in a monolithic HCMOS device. It has a 68030-compatible integer unit (IU) and two independent caches. The WC32P040 contains dual, independent, demand-paged memory management units (MMUs) for instruction and data stream accesses and independent, 4-Kbyte instruction and data caches. The WC32P040 has a 68881/68882-compatible floating-point unit (FPU).

FIG. 1
BLOCK DIAGRAM

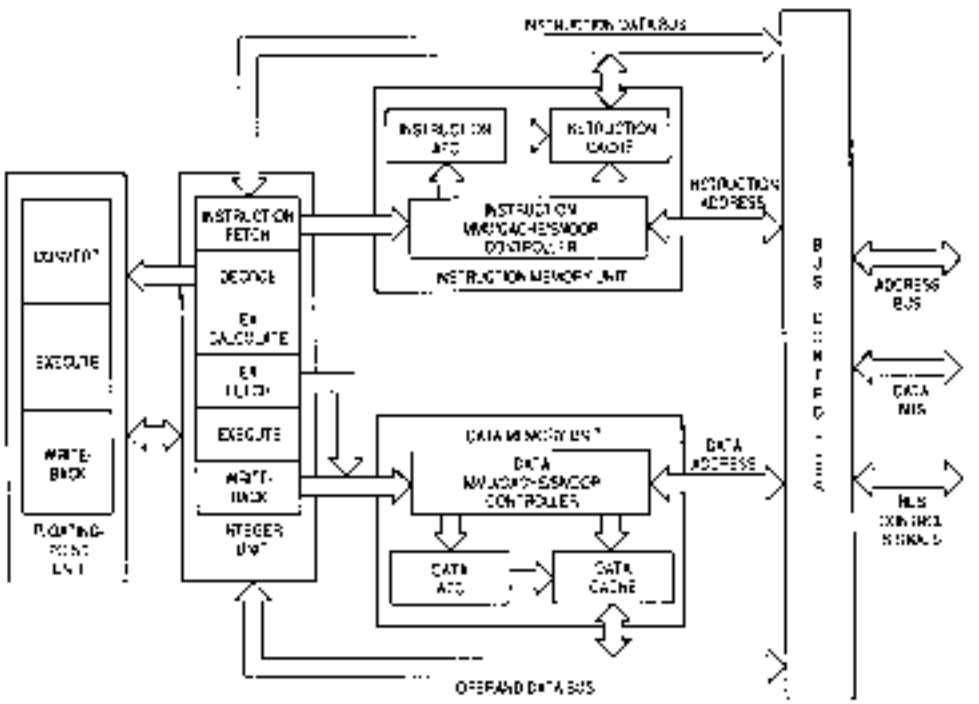
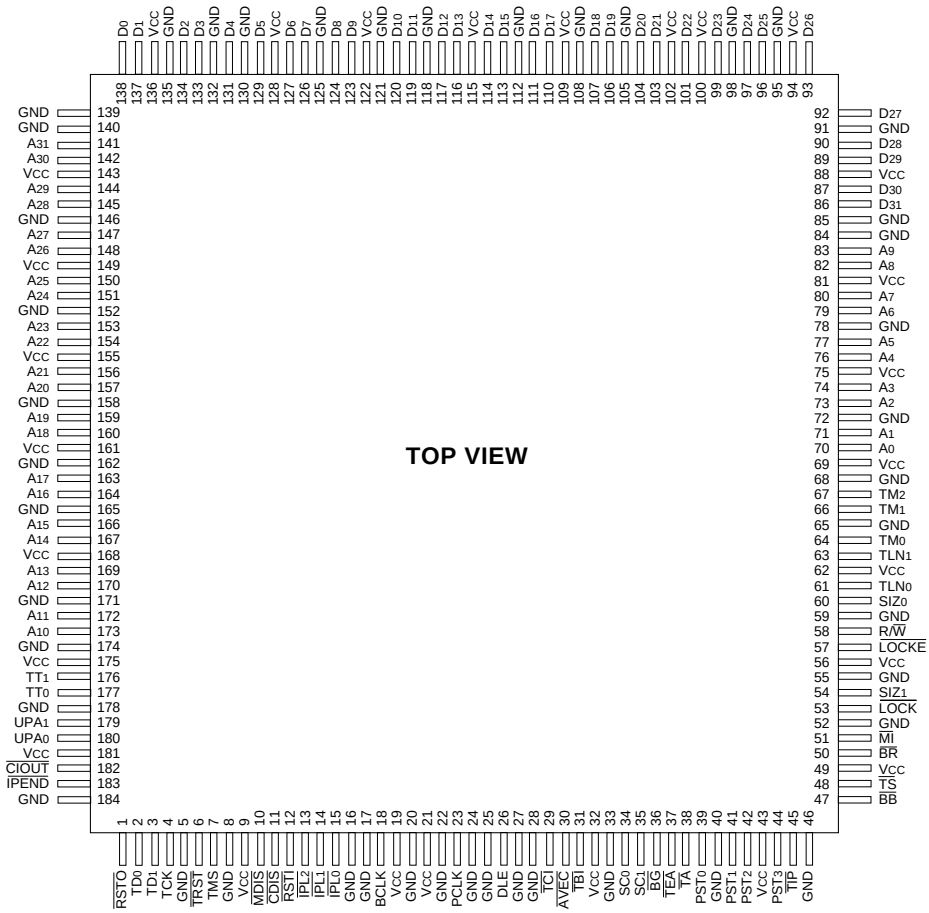
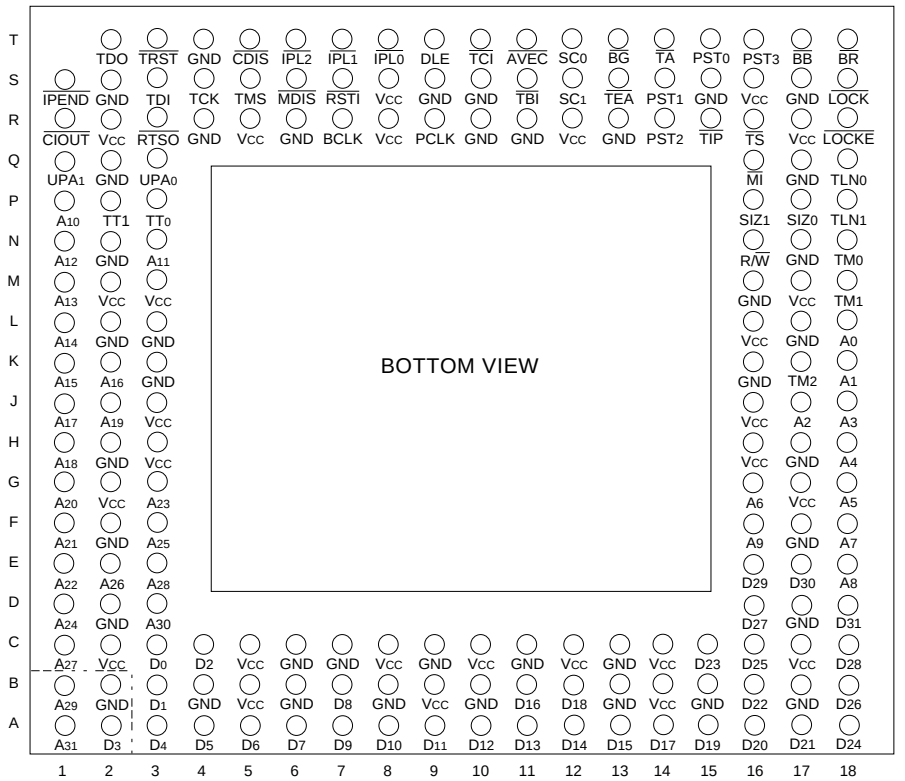


FIG. 2 PIN CONFIGURATION FOR WC32P040-XXM, CQFP (Q4)



Pin Group	GND	Vcc
PLL	17,22,24	19,21
Internal Logic	5,8,10,27,28,33,55,68,95,108,121, 130,135,162,174	9,32,56,69,81,94,100,109,122,136,149, 161,175
Output Drivers	16,20,25,40,46,52,59,65,72,78,84,85, 91,98,105,112,118,125,132,139,140, 146,152,158,165,171,178,184	43,49,62,75,88,102,115,128,143,155, 168,181

FIG. 3 PIN CONFIGURATION FOR WC32P040-XXM, PGA (P4)



Pin Group	GND	Vcc
PLL	S9,R6,R10	R8,S8
Internal Logic	C6,C7,C9,C11,C13,K3,L3,M16,R4, R11,R13,S6,S10,T4	C5,C8,C10,C12,C14,H3,H16,J3,J16, L16,M3,R5,R12
Output Drivers	B2,B4,B6,B8,B10,B13,B15,B17,D2, D17,F2,F17,H2,H17,L2,L17,N2,N17, Q2,Q17,S2,S15,S17	B5,B9,B14,C2,C17,G2,G17,M2,M17, R2,R17,S16

DATA FORMATS

The WC32P040 supports the basic data formats of the 68000 family. Some data formats apply only to the IU, some only to the FPU, and some to both. In addition, the instruction set supports operations on other data formats such as memory addresses.

DATA FORMATS

Operand Data Format	Size	Supported In	Notes
Bit	1 Bit	IU	–
Bit Field	1-32 Bits	IU	Field of Consecutive Bits
Binary-Coded Decimal (BCD)	8 Bits	IU	Packed: 2 Digits/Byte; Unpacked: 1 Digit/Byte
Byte Integer	8 Bits	IU, FPU	–
Word Integer	16 Bits	IU, FPU	–
Long-Word Integer	32 Bits	IU, FPU	–
Quad-Word Integer	64 Bits	IU	Any Two Data Registers
16-Byte	128 Bits	IU	Memory Only, Aligned to 16-Byte Boundary
Single-Precision Real	32 Bits	FPU	1-Bit Sign, 8-Bit Exponent, 23-Bit Fraction
Double-Precision Real	64 Bits	FPU	1-Bit Sign,11-Bit Exponent, 52-Bit Fraction
Extended-Precision Real	80 Bits	FPU	1-Bit Sign,15-Bit Exponent, 64-Bit Mantissa

ADDRESSSING

The WC32P040 supports the basic addressing modes of the 68000 family. The register indirect addressing modes support postincrement, predecrement, offset, and indexing. The program counter indirect mode also has indexing and offset capabilities.

ADDRESSING MODES

Addressing	Syntax
Register Direct	
Data Register Direct	Dn
Address Register Direct	An
Register Indirect	
Address Register Indirect	(An)
Address Register Indirect with Postincrement	(An) +
Address Register Indirect with Predecrement	- (An)
Address Register Indirect with Displacement	(d_{16},An)
Register Indirect with Index	
Address Register Indirect with Index (8-Bit Displacement)	(d_8,An,Xn)
Address Register Indirect with Index (Base Displacement)	(bd,An,Xn)
Memory Indirect	
Memory Indirect Postindexed	([bd,An],Xn,od)
Memory Indirect Preindexed	([bd,An,Xn],od)
Program Counter Indirect with Displacement	(d_{16},PC)
Program Counter Indirect with Index	
PC Indirect with Index (8-Bit Displacement)	(d_8,PC,Xn)
PC Indirect with Index (Base Displacement)	(bd,PC,Xn)
Program Counter Memory Indirect	
PC Memory Indirect Postindexed	([bd,PC],Xn,od)
PC Memory Indirect Preindexed	([bd,PC,Xn],od)
Absolute	
Absolute Short	(xxx).W
Absolute Long	(xxx).L
Immediate	#<xxx>

INSTRUCTION SET SUMMARY

Opcode	Operation	Syntax
ABCD	BCD Source + BCD Destination + X ⇨ Destination	ABCD Dy,Dx ABCD -(Ay),-(Ax)
ADD	Source + Destination ⇨ Destination	ADD <ea>,Dn ADD Dn,<ea>
ADDA	Source + Destination ⇨ Destination	ADDA <ea>,An
ADDI	Immediate Data + Destination ⇨ Destination	ADDI #<data>,<ea>
ADDQ	Immediate Data + Destination ⇨ Destination	ADDQ #<data>,<ea>
ADDX	Source + Destination + X ⇨ Destination	ADDX Dy,Dx ADDX -(Ay),-(Ax)
AND	Source Λ Destination ⇨ Destination	AND <ea>,Dn AND Dn,<ea>
ANDI	Immediate Data Λ Destination ⇨ Destination	ANDI #<data>,<ea>
ANDI to CCR	Source Λ CCR ⇨ CCR	ANDI #<data>,CCR
ANDI to SR	If supervisor state then Source Λ SR ⇨ SR else TRAP	ANDI #<data>,SR
ASL,ASR	Destination Shifted by count ⇨ Destination	ASd Dx,Dy[1] ASd #<data>,Dy[1] ASd <ea>[1]
Bcc	It condition true then PC + dn ⇨ PC	Bcc <label>

INSTRUCTION SET SUMMARY (cont.)

Opcode	Operation	Syntax
BCHG	~(bit number of Destination) ⇾ Z; ~(bit number ot Destination) ⇾ (bit number) of Destination	BCHG Dn,<ea> BCHG #<data>,<ea>
BCLR	~(bit number ot Destination) ⇾ Z; 0 ⇾ bit number ot Destination	BCLR Dn,<ea> BCLR #<data>,<ea>
BFCHG	~(bit field ot Destination) ⇾ bit field of Destination	BFCHG <ea> {offset:width}
BFCLR	0 ⇾ bit field of Destination	BFCLR <ea> {offset:width}
BFEXTS	bit field of Source ⇾ Dn	BFEXTS <ea> {offset:width}, Dn
BFEXTU	bit offset of Source ⇾ Dn	BFEXTU <ea> {offset:width}, Dn
BFFFO	bit offset of Source Bit Scan ⇾ Dn	BFFFO <ea> {offset:width}, Dn
BFINS	Dn ⇾ bit field of Destination	BFINS Dn,<ea> {offset:width}
BFSET	1s ⇾ bit field of Destination	BFSET <ea> {offset:width}
BFTST	bit field of Destination	BFTST <ea> {offset:width}
BKPT	Run breakpoint acknowledge cycle; TRAP as illegal instruction	BKPT #<data>
BRA	PC+dn ⇾ PC	BRA <label>
BSET	~(bit number ot Destination) ⇾ Z; 1 ⇾ bit number of Destination	BSET Dn,<ea> BSET #<data>,<ea>
BSR	SP - 4 ⇾ SP; PC ⇾ (SP); PC + dn ⇾ PC	BSR <label>
BTST	–(bit number of Destination) ⇾ Z	BTST Dn,<ea> BTST #<data>,<ea>
CAS	CAS Destination – Compare Operand ⇾ cc; if Z, Update Operand ⇾ Destination else Destination ⇾ Compare Operand	CAS Dc,Du,<ea>
CAS2	CAS2 Destination 1 – Compare 1 ⇾ cc; if Z, Destination 2 – Compare ⇾ cc; if Z, Update 1 ⇾ Destination 1; Update 2 ⇾ Destination 2 else Destination 1 ⇾ Compare 1; Destination 2 ⇾ Compare 2	CAS2 Dc1-Dc2,Du1-Du2,(Rn1)-(Rn2)
CHK	If Dn < 0 or Dn > Source then TRAP	CHK <ea>,Dn
CHK2	If Rn < LB or If Rn > UB then TRAP	CHK2 <ea>,Rn
CINV	If supervisor state then invalidate selected cache lines else TRAP	CINVL <caches>, (An) CINVP <caches>, (An) CINVA <caches>
CLR	0 ⇾ Destination	CLR <ea>
CMP	Destination – Source ⇾ cc	CMP <ea>,Dn
CMPA	Destination – Source	CMPA <ea>,An
CMPI	Destination – Immediate Data	CMPI #<data>,<ea>
CMPM	Destination – Source ⇾ cc	CMPM (Ay)+,(Ax)+
CMP2	Compare Rn < LB or Rn > UB and Set Condition Codes	CMP2 <ea>,Rn
CPUSH	If supervisor state then it data cache push selected dirty data cache lines; invalidate selected cache lines else TRAP	CPUSHL <caches>, (An) CPUSHP <caches>, (An) CPUSHA <caches>
DBcc	If condition false then (Dn-1 ⇾ Dn; if (Dn ≠ -1 then PC + dn PC)	DBcc Dn,<label>
DIVS, DIVSL	Destination + Source ⇾ Destination	DIVS.W <ea>,Dn 32 + 16 ⇾ 16r:16q DIVS.L <ea>,Dq 32 + 32 ⇾ 32q DIVS.L <ea>,Dr:Dq 64 + 32 ⇾ 32r:32q DIVSL.L <ea>,Dr:Dq 32 + 32 ⇾ 32r:32q
DIVU, DIVUL	Destination + Source ⇾ Destination	DIVU.W <ea>,Dn 32 + 16 ⇾ 16r:16q DIVU.L <ea>,Dq 32+32 ⇾ 32q DIVU.L <ea>,Dr:Dq 64 + 32 ⇾ 32r:32q DIVUL.L <ea>,Dr:Dq 32 + 32 ⇾ 32r:32q
EOR	Source ⊕ Destination ⇾ Destination	EOR Dn,<ea>
EORI	Immediate Data ⊕ Destination ⇾ Destination	EORI #<data>,<ea>
EORI to CCR	Source ⊕ CCR ⇾ CCR	EORI #<data>,CCR

INSTRUCTION SET SUMMARY (cont.)

Opcode	Operation	Syntax
EORI to SR	If supervisor state	EORI #<data>,SR then Source ⊕ SR ◗ SR else TRAP
EXG	Rx ◖◗ Ry	EXG Dx,Dy EXG Ax,Ay EXG Dx,Ay EXG Ay,Dx
EXT,EXTB	Destination Sign – Extended ◗ Destination	EXT.W Dn extend byte to word EXT.L L Dn extend word to long word EXTB.L Dn extend byte to long word
FABS	Absolute Value of Source ◗ FPn	FABS.<fmt> <ea>,FPn FABS.X FPm,FPn FABS.X FPn FrABS.<fmt> <ea>,FPn(2) FrABS.X FPm,FPn(2) FrABS.X FPn(3)
FADD	Source + FPn ◗ FPn	FADD.<fmt, <ea>,FPn FADD.X FPm,FPn FrADD.<fmt> <ea>,FPn(2) FrADD.X FPm,FPn(2)
FBcc	If condition true then PC + d_n ◗ PC	FBcc.SIZE <label>
FCMP	FPn – Source	FCMP.<fmt> <ea>,FPn FCMP.X FPm,FPn
FDBcc	It condition true then no operation else Dn-1 ◗ Dn if Dn ≠ -1 then PC + d_n ◗ PC else execute next instruction	FDBcc Dn,<label>
FDIV	FPn + Source ◗ FPn	FDIV.<tmt> <ea>,FPn FDIV.X FPm,FPn FrDIV.<fmt> <ea>,FPn(2) FrDIV.X FPm,FPn(2)
FMOVE	Source ◗ Destination	FMOVE.<fmt> <ea>,FPn FMOVE.<fmt> FPM,<ea> FMOVE.P FPm,<ea>{Dn} FMOVE.P FPm,<ea>{#k} FrMOVE.<fmt> <ea>,FPn(2)
FMOVE	Source ◗ Destination	FMOVE.L <ea>,FPcr FMOVE.L FPcr,<ea>
FMOVEM	Register List ◗ Destination Source ◗ Register List	FMOVEM.X <list>,<ea>(3) FMOVEM.X Dn,<ea> FMOVEM.X <ea>,<list>(3) FMOVEM.X <ea>,Dn
FMOVEM	Register List ◗ Destination Source ◗ Register List	FMOVEM.L <list>,<ea>(4) FMOVEM.L <ea>,<list>(4)
FMUL	Source x FPn ◗ FPn	FMUL.<fmt> <ea>,FPn FMUL.X FPm,FPn FrMUL<fmt> <ea>,FPn(2) FrMUL.X FPm,FPn(3)
FNEG	–(Source) ◗ FPn	FNEG.<fmt> <ea>,FPn FNEG.X FPm,FPn FNEG.X FPn FrNEG.<fmt> <ea>,FPn(2) FrNEG.X FPm,FPn(2) FrNEG.X FPn(2)
FNOP	None	FNOP
FRESTORE	If in supervisor state then FPU State Frame ◗ Internal State else TRAP	FRESTORE <ea>

INSTRUCTION SET SUMMARY (cont.)

Opcode	Operation	Syntax
FSAVE	If in supervisor state then FPU Internal State ⇨ State Frame else TRAP	FSAVE <ea>
FScc	If condition true then 1s ⇨ Destination else 0s ⇨ Destination	FScc.SIZE <ea>
FSGLDIV	FPn ÷ Source ⇨ FPn	FSGLDIV.<fmt> <ea>,FPn FSGLDIV.X FPm,FPn
FSGLMUL	Source x FPn ⇨ FPn	FSGMUL.<tmt> <ea>,FPn FSGLMUL.X FPm, FPn
FSQRT	Square Root of Source ⇨ FPn	FSQRT.<fmt> <ea>,FPn FSQRT.X FPm,FPn FSQRT.X FPn FrSQRT.<fmt> <ea,,FPn(2) FrSQRT FPm,FPn(2) FrSQRT FPn(2)
FSUB	FPn – Source ⇨ FPn	FSUB.<fmt> <ea>,FPn FSUB.X FPm,FPn FrSUB.<tmt> <ea>,FPn(2) FrSUB.X FPm,FPn3(2)
FTRAPcc	If condition true then TRAP	FTRAPcc FTRAPcc.W #<data> FTRAPcc.L #<data>
FTST	Condition Codes tor Operand ⇨ FPCC	FTST.dmt> <ea> FTST.X FPm
ILLEGAL	SSP – 2 ⇨ SSP; Vector Offset ⇨ (SSP); SSP – 4 ⇨ SSP; PC ⇨ (SSP); SSp – 2 ⇨ SSP; SR ⇨ (SSP) Illegal Instruction Vector Address ⇨ PC	ILLEGAL
JMP	Destination Address ⇨ PC	JMP <ea>
JSR	SP – 4 ⇨ SP; PC ⇨ (SP) Destination Address ⇨ PC	JSR <ea>
LEA	<ea> ⇨ An	LEA <ea>,An
LINK	SP – 4 ⇨ SP;An ⇨ (SP) SP ⇨ An, SP + d ⇨ SP	LINK An,d_n
LSL,LSR	Destination Shifted by count ⇨ Destination	LSd Dx,Dy(1) LSd #<data>,Dy(1) LSd <ea>(1)
MOVE	Source ⇨ Destination	MOVE <ea>,<ea>
MOVEA	Source ⇨ Destination	MOVEA <ea>, An
MOVE from CCR	CCR ⇨ Destination	MOVE CCR,<ea>
MOVE to CCR	Source ⇨ CCR	MOVE <ea>,CCR
MOVE from SR	If supervisor state then SR ⇨ Destination else TRAP	MOVE SR,<ea>
MOVE to SR	If supervisor state then Source ⇨ SR else TRAP	MOVE <ea>,SR
MOVE USP	It supervisor state then USP ⇨ An or An ⇨ USP else TRAP	MOVE USP,An MOVE An,USP
MOVE1 6	Source block ⇨ Destination block	MOVE16 (Ax)+, (Ay)+(5) MOVE16 (xxx).L, (An) MOVE16 (An), (xxx).L MOVE16 (An)+, (xxx).L
MOVEC	If supervisor state then Rc ⇨ Rn or Rn ⇨ Rc else TRAP	MOVEC Rc,Rn MOVEC Rn,Rc
MOVEM	Registers ⇨ Destination Source ⇨ Registers	MOVEM <list>,<ea>(3) MOVEM <ea>,<list>(3)
MOVEP	Source ⇨ Destination	MOVEP Dx,(d_n,Ay) MOVEP (d_n,Ay),Dx

INSTRUCTION SET SUMMARY (cont.)

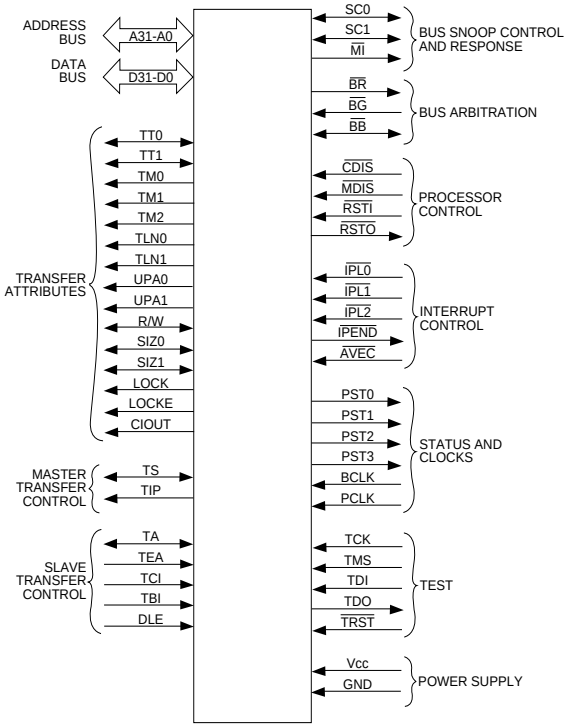
Opcode	Operation	Syntax
MOVEQ	Immediate Data ⇨ Destination	MOVEQ #<data>,Dn
MOVES	If supervisor state then Rn ⇨ Destination [DFC) or Source [SFC] ⇨ Rn else TRAP	MOVES Rn,<ea> MOVES <ea>,Rn
MULS	Source x Destination ⇨ Destination	MULS.W <ea>,Dn 16 x 16 ⇨ 32 MULS.L <eai,DI 32 x 32 ⇨ 32 MULS.L <ea>,Dh-DI 32 x 32 ⇨ 64
MULU	Source x Destination ⇨ Destination	MULU.W <ea>,Dn 16 x 16 ⇨ 32 MULU.L <ea>,DI 32 x 32 ⇨ 32 MULU.L <ea>,Dh-DI 32 x 32 ⇨ 64
NBCD	0 – (Destination10) – X ⇨ Destination	NBCD <ea>
NEG	0 – (Destination) ⇨ Destination	NEG <ea>
NEGX	0 – (Destination) – X ⇨ Destination	NEGX <ea>
NOP	None	NOP
NOT	~ Destination ⇨ Destination	NOT <ea>
OR	Source V Destination ⇨ Destination	OR <ea>,Dn OR Dn,<ea>
ORI	Immediate Data V Destination ⇨ Destination	ORI #<data>,<ea>
ORI to CCR	Source V CCR ⇨ CCR	ORI #<data>,CCR
ORI to SR	If supervisor state then Source V SR ⇨ SR else TRAP	ORI #<data>,SR
PACK	Source (Unpacked BCD) + adjustment ⇨ Destination (Packed BCD)	PACK -(Ax),-(Ay),#(adjustment) PACK Dx,Dy,#(adjustment)
PEA	SP – 4 ⇨ SP; <ea> ⇨ (SP)	PEA <ea>
PFLUSH	If supervisor state then invalidate instruction and data ATC entries for destination address else TRAP	PFLUSH (An) PFLUSHN (An) PFLUSHA PFLUSHAN
PTEST	If supervisor state then logical address status ⇨ MMUSR; entry ⇨ ATC else TRAP	PTESTR (An) PTESTW (An)
RESET	If supervisor state then Assert $\overline{\text{RSTO}}$ Line else TRAP	RESET
ROL, ROR	Destination Rotated by count ⇨ Destination	ROd Rx,Dy(1) ROd #<data>,Dy(1)
ROXL, ROXR	Destination Rotated with X by count ⇨ Destination	ROXd Dx,Dy(1) ROXd #<data>,Dy(1) ROXd <ea>(1)
RTD	(SP) ⇨ PC; SP + 4 + d_n ⇨ SP	RTD #(d_n)
RTE	If supervisor state then (SP) ⇨ SR; SP + 2 ⇨ SP; (SP) ⇨ PC; SP + 4 ⇨ SP; restore state and deallocate stack according to (SP) else TRAP	RTE
RTR	(SP) ⇨ CCR; SP + 2 ⇨ SP; (SP) ⇨ PC; SP + 4 ⇨ SP	RTR
RTS	(SP) ⇨ PC; SP + 4 ⇨ SP	RTS
SBCD	Destination10 – Source_{10} – X ⇨ Destination	SBCD Dx,Dy SBCD –(Ax),–(Ay)
Scc	If condition true then 1s ⇨ Destination else 0s ⇨ Destination	Scc <ea>
STOP	If supervisor state then Immediate Data ⇨ SR; STOP elseTRAP	STOP #<data>

INSTRUCTION SET SUMMARY (cont.)

Opcode	Operation	Syntax
SUB	Destination – Source ◗ Destination	SUB <ea>,Dn SUB Dn,<ea>
SUBA	Destination – Source ◗ Destination	SUBA <ea>,An
SUBI	Destination – Immediate Data ◗ Destination	SUBI #<data>,<ea>
SUBQ	Destination – Immediate Data ◗ Destination	SUBQ #<data>,<ea>
SUBX	Destination – Source – X ◗ Destination	SUBX Dx,Dy SUBX (Ax), (Ay)
SWAP	Register 31 – 16 ◗ Register 15 – 0	SWAP Dn
TAS	Destination Tested ◗ Condition Codes; 1 ◗ bit 7 of Destination	TAS <ea>
TRAP	SSP – 2 ◗ SSP; Format + Offset ◗ (SSP) SSP – 4 ◗ SSP; PC ◗ (SSP); SSP - 2 ◗ SSP; SR ◗ (SSP); Vector Address ◗ PC	TRAP #<vector>
TRAPcc	If cc then TRAP	TRAPcc TRAPcc.W #<data> TRAPcc.L #<data>
TRAPV	If V then TRAP	TRAPV
TST	Destination Tested ◗ Condition Codes	TST <ea>
UNLK	An ◗ SP; (SP) ◗ An; SP + 4 ◗ SP	UNLK An
UNPK	Source (Packed BCD) + adjustment ◗ Destination (Unpacked BCD)	UNPACK –(Ax), –(Ay), # (adjustment) UNPACK Dx,Dy, #(adjustment)

NOTES:
1. Where d is direction, left or right.
2. Where r is rounding precision, single or double precision.
3. List refers to register.
4. List refers to control registers only.
5. MOVE16 (ax)+, (ay)+ is functionally the same as MOVE16 (ax), (ay)+ when ax = ay. The address register is only incremented once, and the line is copied over itself rather than to the next line.

FIG. 4
FUNCTIONAL SIGNAL GROUPS



SIGNAL INDEX

Signal Name	Mnemonic	Function
Address Bus	A31-A0	32-bit address bus used to address any of 4-Gbytes.
Data Bus	D31-D0	32-bit data bus used to transfer up to 32 bits of data per bus transfer.
Transfer Type	TT1,TT0	Indicates the general transfer type: normal, MOVE16, alternate logical function code, and acknowledge.
Transfer Modifier	TM2-TM0	Indicates supplemental information about the access.
Transfer Line Number	TLN1-TLN0	Indicates which cache line in a set is being pushed or loaded by the current line transfer.
User-Progammable Attributes	UPA1,UPA0	User-defined signals, controlled by the corresponding user attribute bits from the address translation entry.
Read/Write	R/$\overline{W}$	Identifies the transfer as a read or write.
Transfer Size	SIZ0/SIZ1	Indicates the data transfer size. These signals, together with A0 and A1, define the active sections of the data bus.
Bus Lock	$\overline{LOCK}$	Indicates a bus transfer is part of a read-modify-write operation, and the sequence of transfers should be interrupted.
Bus Lock End	$\overline{LOCKE}$	Indicates the current transfer is the last in a locked sequence of transfers.
Cache Inhibit Out	$\overline{CIOUT}$	Indicates the processor will not cache the current bus transfer.
Transfer Start	$\overline{TS}$	Indicates the beginning of the bus transfer.
Transfer on Progress	$\overline{TIP}$	Asserted for the duration of a bus transfer.
Transfer Acknowledge	$\overline{TA}$	Asserted to acknowledge a bus transfer.
Transfer Error Acknowledge	$\overline{TEA}$	Indicates an error condition exists for a bus transfer.
Transfer Cache Inhibit	$\overline{TCI}$	Indicates the current bus transfer should not be cached.
Transfer Burst Inhibit	$\overline{TBI}$	Indicates the slave cannot handle a line burst access.
Data Latch Enable	DLE	Alternate clock input used to latch input data when the processor is operating in DLE mode.
Snoop Control	SC1,SC0	Indicates the snooping operation required during an alternate master access.
Memory Inhibit	$\overline{MI}$	Inhibits mem ory devices from responding to an alternate master access during snooping operations.
Bus Request	$\overline{BR}$	Asserted by the processor to request bus mastership.
Bus Grant	$\overline{BG}$	Asserted by an arbiter to grant bus mastership to the processor.
Bus Busy	$\overline{BB}$	Asserted by the current bus master to indicate it has assumed ownership of the bus.
Cache Disable	$\overline{CDIS}$	Dynamically disables the internal caches to assist emulator support.
MMU Disable	$\overline{MDIS}$	Disables the translation mechanism of the MMUs.
Reset In	$\overline{RSTI}$	Processor reset.
Reset Out	$\overline{RSTO}$	Asserted during execution of a RESET instruction to reset external devices.
Interrupt Priority Level	$\overline{IPL2}$-$\overline{IPL0}$	Provides an encoded interrupt level to the processor.
Interrupt Pending	$\overline{IPEND}$	Indicates an interrupt is pending.
Autovector	$\overline{AVEC}$	Used during an interrupt acknowledge transfer to request internal generation of the vector number.
Processor Status	PST3-PST0	Indicates internal processor status.
Processor Clock	PCLK	Clock input used for internal logic timing. The PCLK frequency is exactly 2 x the BLCK frequency.
Test Clock	TCK	Clock signal for the IEEE P1149.1 Test Access Port (TAP).
Test Mode Select	TMS	Selects the principle operations of the test-support circuitry.
Test Data Input	TDI	Serial data input for the TAP.
Test Data Output	TDO	Serial data output for the TAP.
Test Reset	$\overline{TRST}$	Provides an asynchronous reset of the TAP controller.
Power Supply	Vcc	Power supply.
Ground	GND	Ground connection.

MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.3 to +7.0	V
Input Voltage	V_{IN}	-0.5 to +7.0	V
Maximum Operating Temperature	T_J	+125	°C
Minimum Operating Temperature	T_A	-55	°C
Storage Temperature	T_{STG}	-55 to +150	°C

POWER DISSIPATION

Buffer Mode	25 MHz	33 MHz
Small Unterminated, $I_{OL} = I_{OH}$ = 5mA	4.9W	6.2W
Large Unterminated, $I_{OL} = I_{OH}$ = 5mA	5.1W	6.6W
Large Terminated, 50 Ω, 2.5V, $I_{OL} = I_{OH}$ = 55mA	6.5W	8.0W

THERMAL CHARACTERISTICS

Parameter	Symbol	Value	Rating
Thermal Resistance, Junction to Case – PGA Package	θ_{JC}	3.0	°C/W

DC ELECTRICAL SPECIFICATIONS

(V_{CC} = 5.0 V_{DC} ±5%)

Characteristics	Symbol	Min	Max	Unit
Input High Voltage	V_{IH}	2.0	Vcc	V
Input Low Voltage	V_{IL}	GND	0.8	V
Undershoot	–	–	0.8	V
Input Leakage Current @ 0.5/2.4V — $\overline{AVEC}$, BCLK, $\overline{BG}$, $\overline{CDIS}$, $\overline{MDIS}$, $\overline{IPLx}$, PCLK, $\overline{RSTI}$, SCx, $\overline{TBI}$, TMx, TLNx, $\overline{TCI}$, TCK, $\overline{TEA}$	I_{IN}	20	20	µA
High-Z (Off State) Leakage Current @ 0.5/2.4 V — An, $\overline{BB}$, $\overline{CIOUT}$, Dn, $\overline{LOCK}$, $\overline{LOCKE}$, R/$\overline{W}$, SIZx, $\overline{TA}$, TDO, $\overline{TIP}$, TMx, TLNx, $\overline{TS}$, TTx, UPAx	I_{TSI}	20	20	µA
Signal Low Input Current, V_{IL} = 0.8V — TMS, TDI, $\overline{TRST}$	I_{IL}	-1.1	-0.18	mA
Signal High Input Current, V_{IH} = 2.0V — TMS, TDI, $\overline{TRST}$	I_{IH}	-0.94	-0.16	mA
Output High Voltage, I_{OH} = 5mA (Small Buffer Mode)	V_{OH}	2.4	–	V
Output Low Voltage, I_{OL} = 5mA (Small Buffer Mode)	V_{OL}	–	0.5	V
Output High Voltage, I_{OH} = 55mA (Large Buffer Mode)	V_{OH}	2.4	–	V
Output Low Voltage, I_{OL} = 55mA (Large Buffer Mode)	V_{OL}	–	0.5	V
Capacitance (1), V_{IN} = 0V, f = 1MHz	C_{IN}	-	20	pF

NOTES:

1. Capacitance is guaranteed by design but not tested.

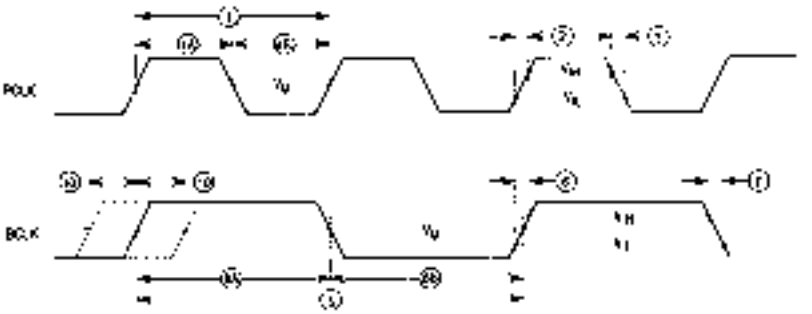
CLOCK AC TIMING SPECIFICATIONS (see Fig. 5)

Characteristic	Specification	25 MHz		33 MHz		Unit
		Min	Max	Min	Max	
Frequency of Operation		20	25	20	33	MHz
PCLK Cycle Time	1	20	25	15	25	ns
PCLK Rise Time	2	–	1.7	–	1.7	ns
PCLK Fall Time	3	–	1.6	–	1.6	ns
PCLK Duty Cycle Measured at 1.5V	4	47.50	52.50	46.67	53.33	%
PCLK Pulse Width High Measured at 1.5V	4A (1)	9.50	10.50	7	8	ns
PCLK Pulse Width Low Measured at 1.5V	4B (1)	9.50	10.50	7	8	ns
BCLK Cycle Time	5	40	50	30	50	ns
BCLK Rise and Fall Time	6,7	–	4	–	3	ns
BCLK Duty Cycle Measured at 1.5V	8	40	60	40	60	%
BCLK Pulse Width High Measured at 1.5V	8A (1)	16	24	12	18	ns
BCLK Pulse Width Low Measured at 1.5V	8B (1)	16	24	12	18	ns
PCLK, BCLK Frequency Stability	9	–	1000	–	1000	ppm
PCLK and BCLK Skew	10	–	9	–	n/a	ns

NOTES:

1. Specification value at maximum frequency of operation.

FIG.5
CLOCK INPUT TIMING DIAGRAM



OUTPUT AC TIMING SPECIFICATIONS (see Fig. 6-10)

Characteristic	Specification	25 MHz				33 MHz				Unit
		Large (1)		Small (2)		Large (1)		Small (2)		
		Min	Max	Min	Max	Min	Max	Min	Max	
BCLK to Address $\overline{CIOUT}$, $\overline{LOCK}$, $\overline{LOCKE}$, R/$\overline{W}$, SIZx, TLN, TMx, TTx, UPAx Valid	11 (3)	9	21	9	30	6.50	18	6.50	25	ns
BCLK to Output Invalid (Output Hold)	12	9	–	9	–	6.50	–	6.50	–	ns
BCLK to $\overline{TS}$ Valid	13	9	21	9	30	6.50	18	6.50	25	ns
BCLK to $\overline{TIP}$ Valid	14	9	21	9	30	6.50	18	6.50	25	ns
BCLK to Data Out Valid	18 (4)	9	23	9	32	6.50	20	6.50	27	ns
BCLK to Data Out Invalid (Output Hold)	19 (4)	9	–	9	–	6.50	–	6.50	–	ns
BCLK to Output Low Inpedance	20 (3,4)	9	–	9	–	6.50	–	6.50	–	ns
BCLK to Data-Out High Impedance	21 (5)	9	20	9	20	6.50	17	6.50	17	ns
BCLK to Multiplexed Address Valid	26 (3)	19	31	19	40	14	26	14	33	ns
BCLK to Multiplexed Address Driven	27 (3,5)	19	–	19	–	14	–	14	–	ns
BCLK to Multiplexed Address High Impedance	28 (3,4,5)	9	18	9	18	6.50	15	6.50	15	ns
BCLK to Multiplexed Data Valid	29 (4,5)	19	–	19	–	14	20	14	20	ns
BCLK to Multiplexed Data Driven	30 (4)	19	33	19	42	14	28	14	35	ns
BCLK to Address, $\overline{CIOUT}$, $\overline{LOCK}$, $\overline{LOCKE}$, R/$\overline{W}$, SIZx, $\overline{TS}$, TLNx, TMx, TTx, UPAx High Impedance	38 (3)	9	18	9	18	6.50	15	6.50	15	ns
BLCLK to $\overline{BB}$, $\overline{TA}$, $\overline{TIP}$ High Impedance	39	19	28	19	28	14	23	14	23	ns
BCLK to $\overline{BR}$, $\overline{BB}$ Valid	40	9	21	9	30	6.50	18	6.50	25	ns
BCLK to $\overline{MI}$ Valid	43	9	21	9	30	6.50	18	6.50	25	ns
BCLK to $\overline{TA}$ Valid	48	9	21	9	30	6.50	18	6.50	25	ns
BCLK to $\overline{IPEND}$, PSTx, $\overline{RSTO}$ Valid	50	9	21	9	30	6.50	18	6.50	25	ns

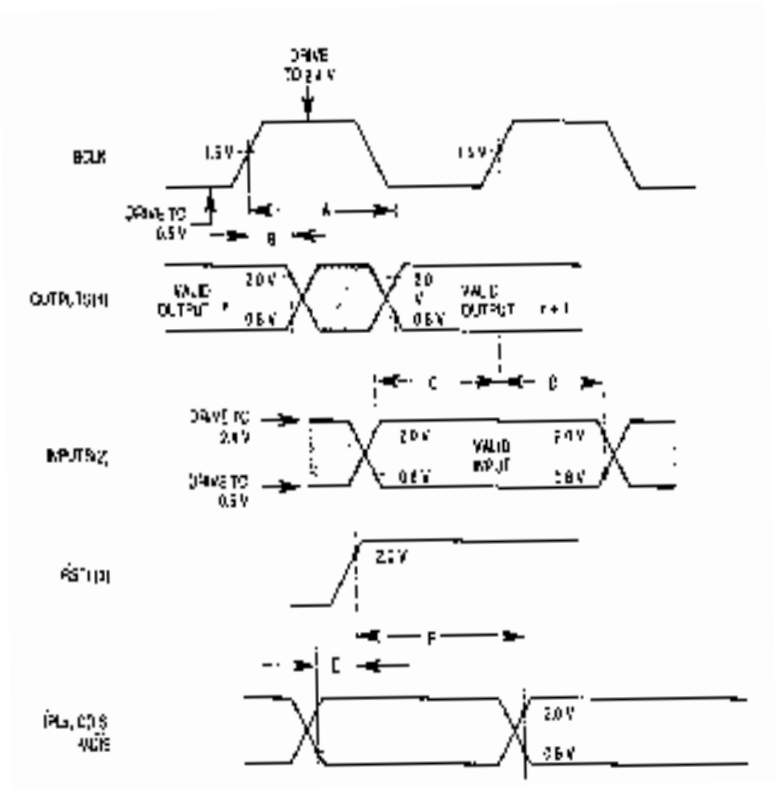
NOTES:

1. Output timing is specified for a valid signal measured at the pin. Large buffer timing is specified driving a 50Ω transmission line with a length characterized by a 2.5ns one-way propagation delay, terminated through 50Ω to 2.5V. Large buffer output impedance is 4-12Ω, resulting in incident wave switching for this environment. All large buffer outputs must be terminated to guarantee operation.
2. Small buffer timing is specified driving an unterminated 30Ω transmission line with a length characterized buy a 2.5ns one-way propagation delay. Small buffer output impedance is typically 30Ω; the small buffer specifications include approximately 5ns for the signal to propagate the length of the transmission line and back.
3. Timing specifications 11, 20, and 38 for address bus output timinng apply when normal bus operation is selected. Specifications 26, 27, and 28 should be used when the multiplexed bus mode of operation is enabled.
4. Timing specifications 18 and 19 for data bus output timing apply when normal bus operation is selected. Specifications 28 and 29 should be used when the multiplexed bus mode of operation is enabled.
5. Timing specifications 21, 27, 28, and 29 are measured from BCLK edges. By design, the 68040 cannot drive address and data simultaneously during multiplexed operations.

INTPUT AC TIMING SPECIFICATIONS (see Fig. 6-10)

Characteristic	Specification	25 MHz		33 MHz		Unit
		Min	Max	Min	Max	
Data-In Valid to BCLK (Setup)	15	5	–	4	–	ns
BCLK to Data-In Valid (Hold)	16	4	–	4	–	ns
BCLK to Data-In High Impedance (Read Followed by Write)	17	–	49	–	36.5	ns
$\overline{TA}$ Valid to BCLK (Setup)	22A	10	–	10	–	ns
$\overline{TEA}$ Valid to BCLK (Setup)	22B	10	–	10	–	ns
$\overline{TCI}$ Valid to BCLK (Setup)	22C	10	–	10	–	ns
$\overline{TBI}$ Valid to BCLK (Setup)	22D	11	–	10	–	ns
BCLK to $\overline{TA}$, $\overline{TEA}$, $\overline{TCI}$, $\overline{TBI}$ Invalid (Hold)	23	2	–	2	–	ns
$\overline{AVEC}$ Valid to BCLK (Setup)	24	5	–	5	–	ns
BCLK to $\overline{AVEC}$ Invalid (Hold)	25	2	–	2	–	ns
DLE Width High	31	8	–	8	–	ns
Data-In Valid to DLE (Setup)	32	2	–	2	–	ns
DLE to Data-In Invalid (Hold)	33	8	–	8	–	ns
BCLK to DLE Hold	34	3	–	3	–	ns
DLE High to BCLK	35	16	–	12	–	ns
Data-In Valid to BCLK (DLE Mode Setup)	36	5	–	5	–	ns
BCLK to Data-In Invalid (DLE Mode Hold)	37	4	–	4	–	ns
$\overline{BB}$ Valid to BCLK (Setup)	41A	7	–	7	–	ns
$\overline{BG}$ Valid to BCLK (Setup)	41B	8	–	7	–	ns
$\overline{CDIS}$, $\overline{MDIS}$ Valid to BCLK (Setup)	41C	10	–	8	–	ns
$\overline{IPLx}$ Valid to BCLK (Setup)	41D	4	–	3	–	ns
BCLK to $\overline{BB}$, $\overline{BG}$, $\overline{CDIS}$, $\overline{IPLx}$, $\overline{MDIS}$ Invalid (Hold)	42	2	–	2	–	ns
Address Valid to BCLK (Setup)	44A	8	–	7	–	ns
SIZx Valid BCLK (Setup)	44B	12	–	8	–	ns
TTx Valid to BCLK (Setup)	44C	6	–	8.5	–	ns
R/$\overline{W}$ Valid to BCLK (Setup)	44D	6	–	5	–	ns
SCx Valid to BCLK (Setup)	44E	10	–	11	–	ns
BCLK to Address, SIZx, TTx, R/$\overline{W}$, SCx Invalid (Hold)	45	2	–	2	–	ns
$\overline{TS}$ Valid to BCLK (Setup)	46	5	–	9	–	ns
BCLK to $\overline{TS}$ Invalid (Hold)	47	2	–	2	–	ns
BCLK to $\overline{BB}$ High Impedance (MC68040 Assumes Bus Mastership)	49	–	9	–	9	ns
$\overline{RSTI}$ Valid to BCLK	51	5	–	4	–	ns
BCLK to $\overline{RSTI}$ Invalid	52	2	–	2	–	ns
Mode Select Setup to $\overline{RSTI}$ Negated	53	20	–	20	–	ns
$\overline{RSTI}$ Negated to Mode Selects Invalid	54	2	–	2	–	ns

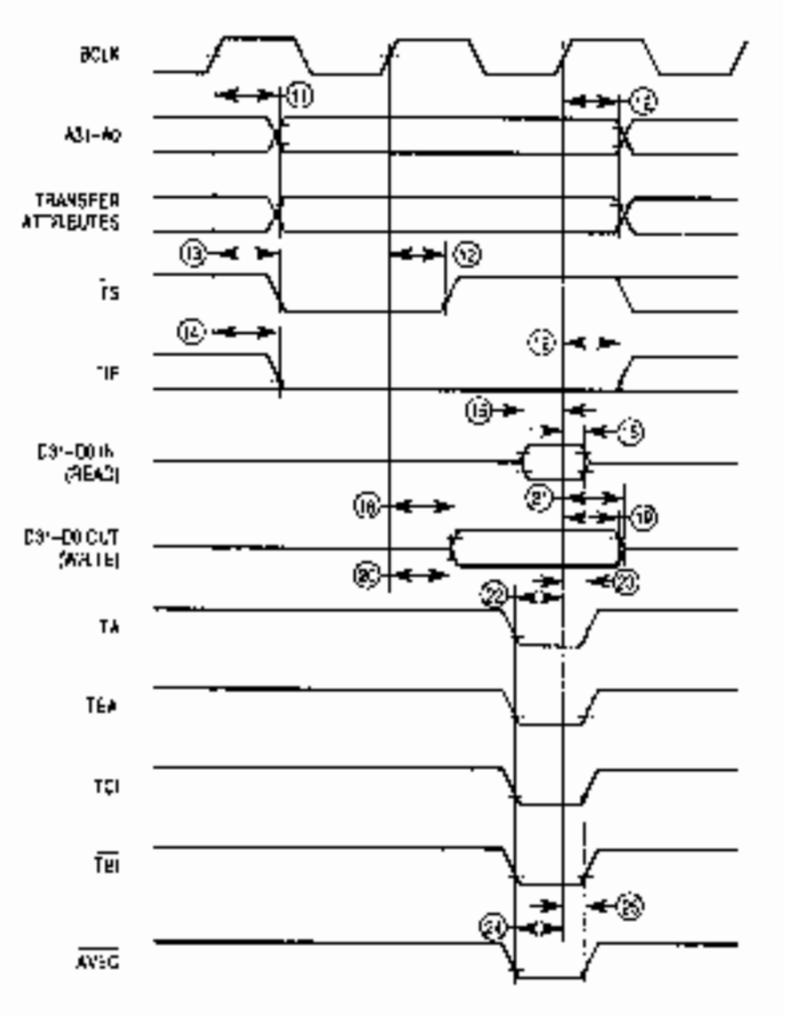
FIG. 6
DRIVE LEVELS AND TEST POINTS FOR AC SPECIFICATONS



NOTE:
1. This output timing is applicable to all parameters specified relative to the rising edge of the clock.
2. This input timing is applicable to all parameters specified relative to the rising edge of the clock.
3. This timing is applicable to all parameters specified relative to the negation of the $\overline{\text{RSTI}}$ signal.

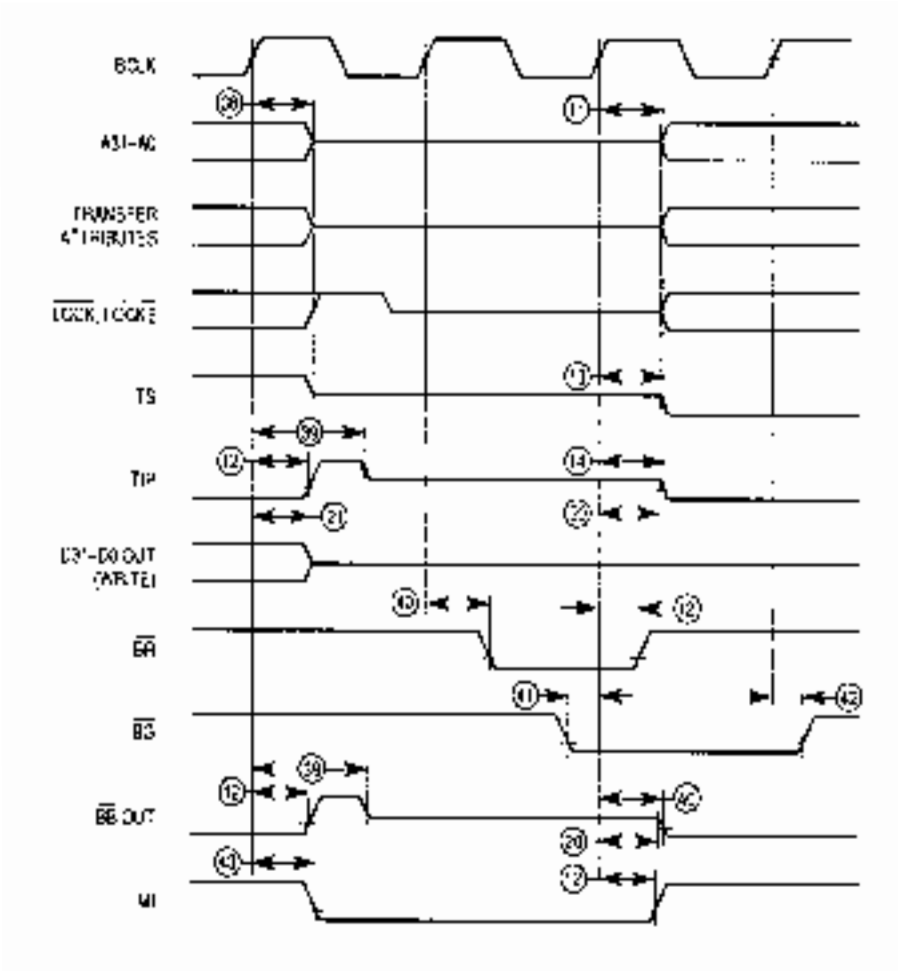
LEGEND:
A. Maximum output delay specification.
B. Minimum output hold time.
C. Minimum input setup time specification.
D. Minimum input hold time specification.
E. Mode select setup time to $\overline{\text{RSTI}}$ negated.
E. Mode select hold time to $\overline{\text{RSTI}}$ negated.

FIG. 7
READ/WRITE TIMING DIAGRAM



NOTE:
Transfer Attribute Signals = UPAx, SIZx, TTx, TMx, TLNx, R/$\overline{W}$, $\overline{LOCK}$, $\overline{LOCKE}$, $\overline{CIOUT}$

FIG. 8
BUS ARBITRATION TIMING DIAGRAM



NOTE:
Transfer Attribute Signals = UPAx, SIZx, TTx, TMx, TLNx, R/$\overline{W}$, $\overline{CIOUT}$

FIG. 9
SNOOP HIT TIMING DIAGRAM

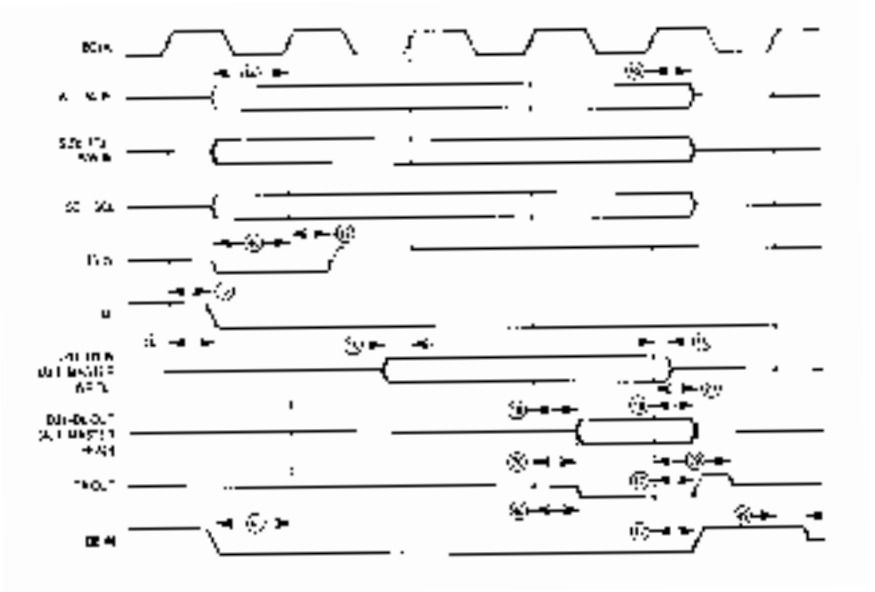


FIG. 10
SNOOP MISS TIMING DIAGRAM

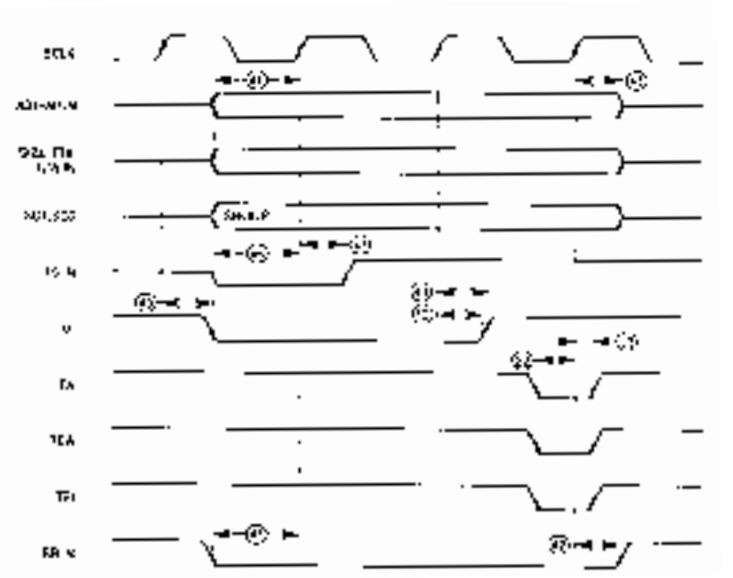


FIG. 11
OTHER SIGNAL TIMING DIAGRAM

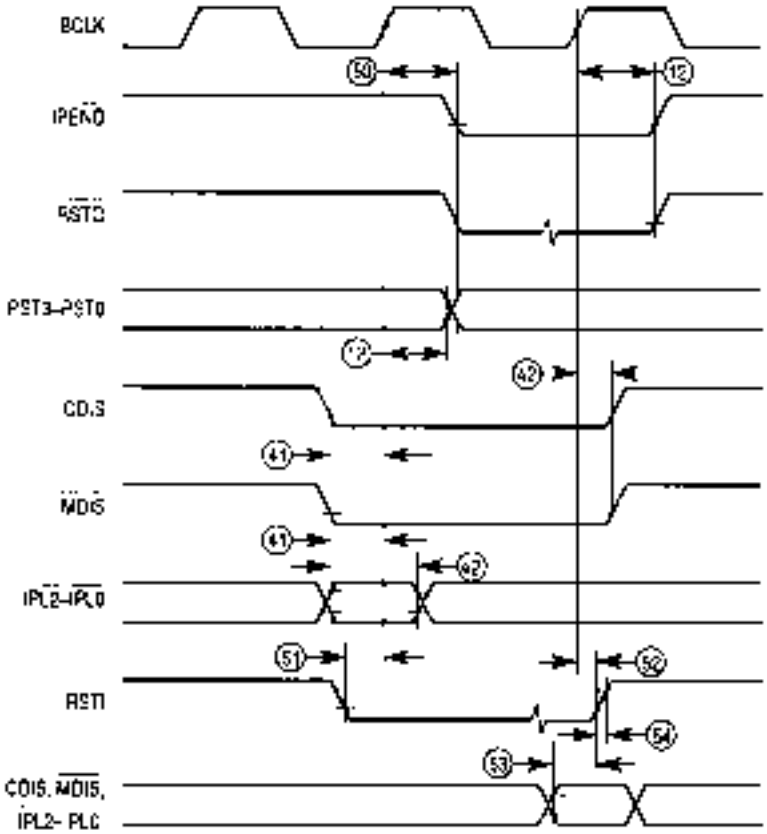


FIG. 12 179 PIN GRID ARRAY, PGA (P4)

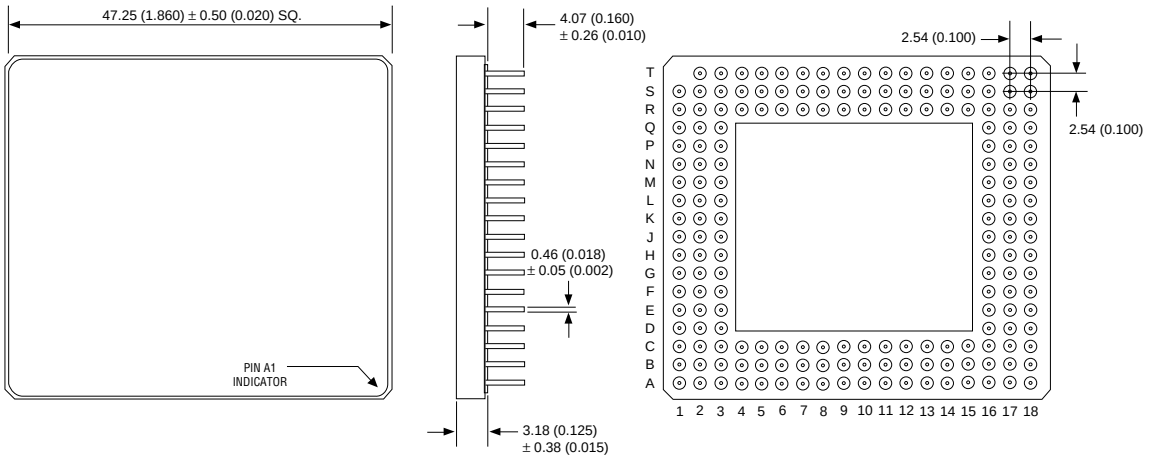


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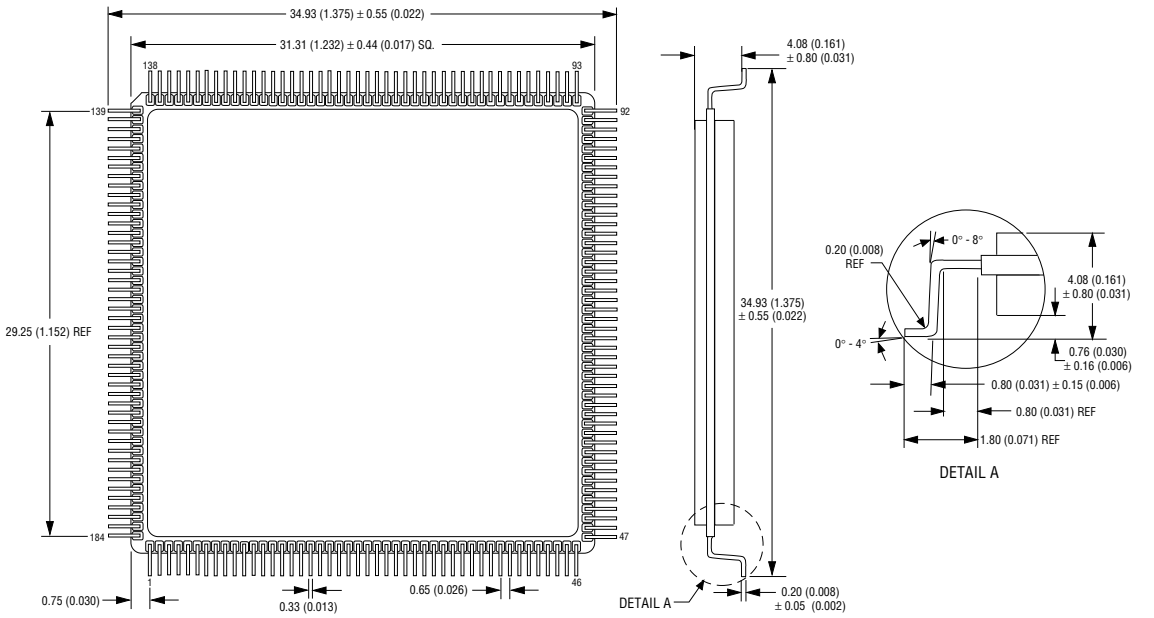
FIG. 13 184 LEAD, CERAMIC QUAD FLAT PACK, CQFP (Q4)



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