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Understanding Embedded - FPGAs (Field Programmable Gate Array)

Embedded - FPGAs, or Field Programmable Gate Arrays, are advanced integrated circuits that offer unparalleled flexibility and performance for digital systems. Unlike traditional fixed-function logic devices, FPGAs can be programmed and reprogrammed to execute a wide array of logical operations, enabling customized functionality tailored to specific applications. This reprogrammability allows developers to iterate designs quickly and implement complex functions without the need for custom hardware.

Applications of Embedded - FPGAs

The versatility of Embedded - FPGAs makes them indispensable in numerous fields. In telecommunications.

Details	
Product Status	Obsolete
Number of LABs/CLBs	-
Number of Logic Elements/Cells	2304
Total RAM Bits	18432
Number of I/O	256
Number of Gates	50000
Voltage - Supply	3V ~ 3.6V
Mounting Type	Surface Mount
Operating Temperature	0°C ~ 70°C
Package / Case	304-BFQFP
Supplier Device Package	304-PQFP (40x40)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/at40k40lv-3fqc

The Symmetrical Array

At the heart of the Atmel architecture is a symmetrical array of identical cells (Figure 1). The array is continuous from one edge to the other, except for bus repeaters spaced every four cells (Figure 2). At the intersection of each repeater row and column is a 32 x 4 RAM block accessible by adjacent buses. The Ram can be configured as either a single-ported or dual-ported RAM, with either synchronous or asynchronous operation.

Figure 1. Symmetrical Array Surrounded by I/O (AT40K20)

= I/O Pad

= AT40K Cell

= Repeater Row

= Repeater Column

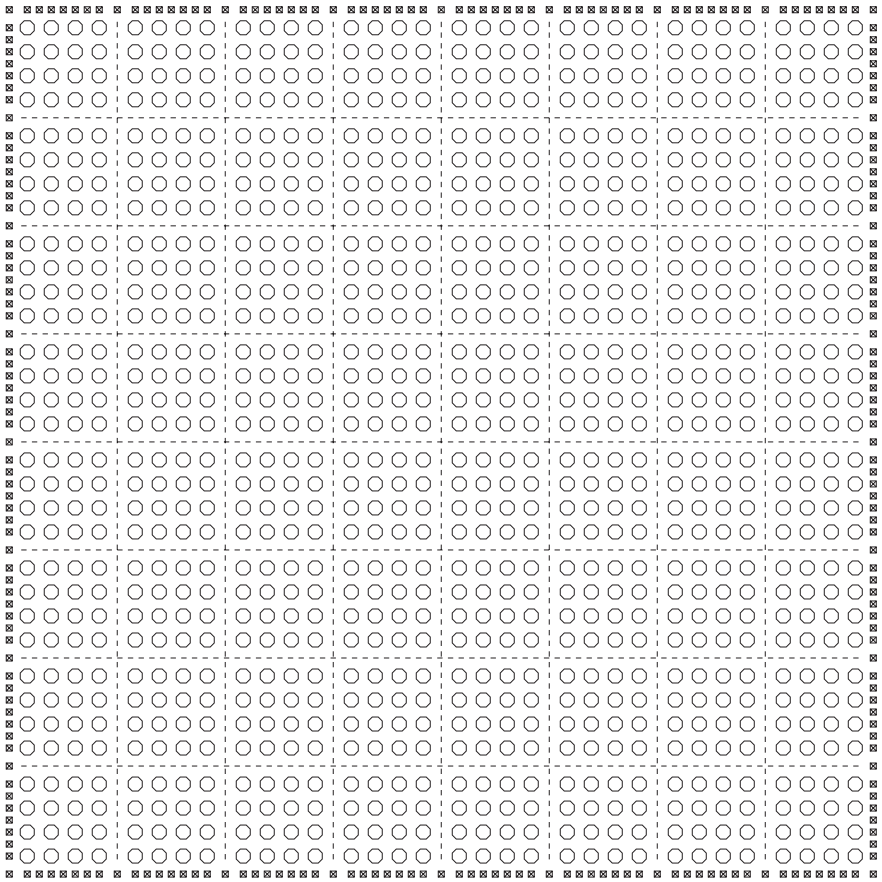
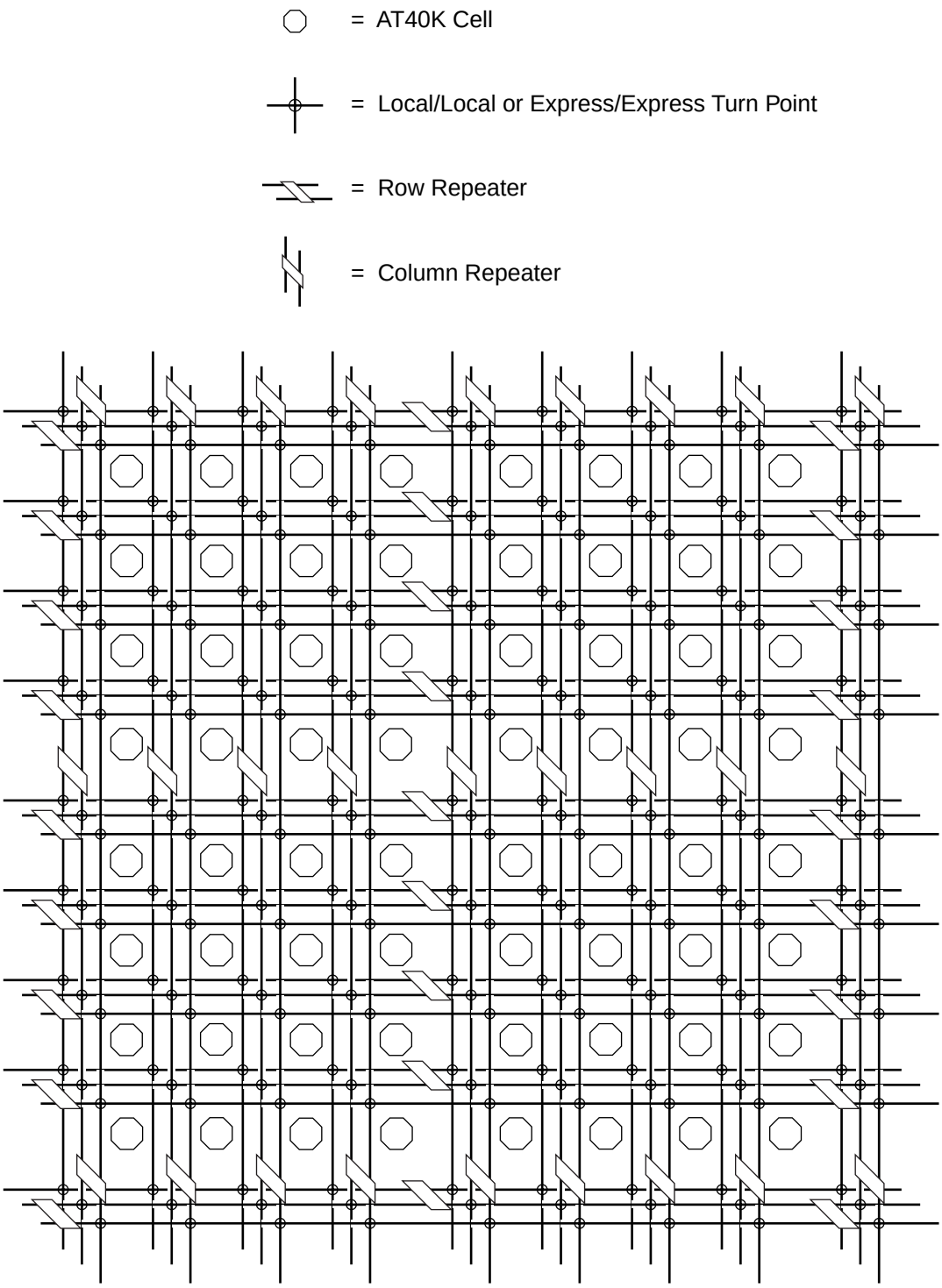


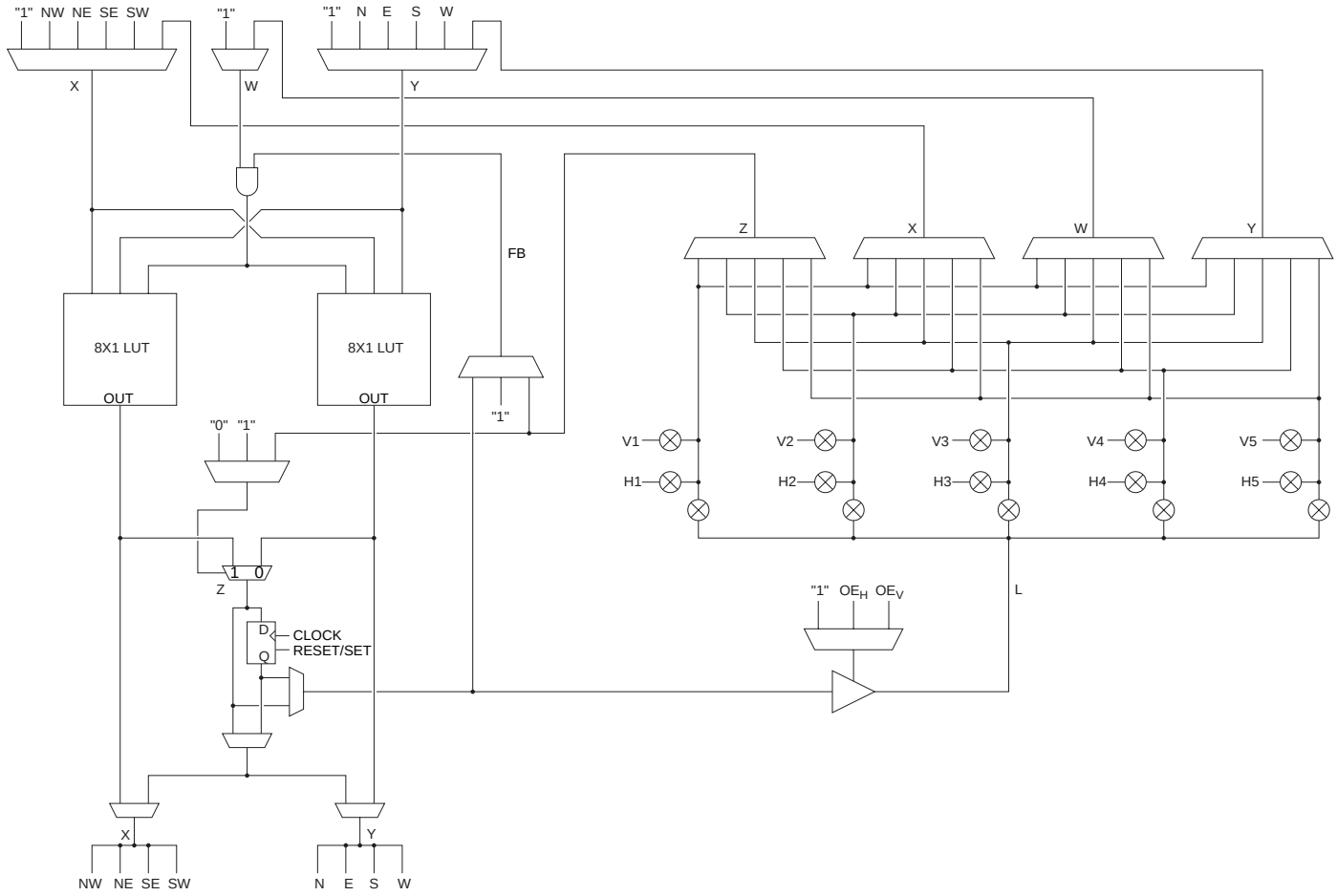
Figure 3. Busing Plane (one of five)



The Cell

Figure 5 depicts the AT40K cell. Configuration bits for separate muxes and pass gates are independent. All permutations of programmable muxes and pass gates are legal. Vn is connected to the vertical local bus in plane n. Hn is connected to the horizontal local bus in plane n. A local/local turn in plane n is achieved by turning on the two pass gates connected to Vn and Hn. Up to five simultaneous local/local turns are possible.

Figure 5. The Cell



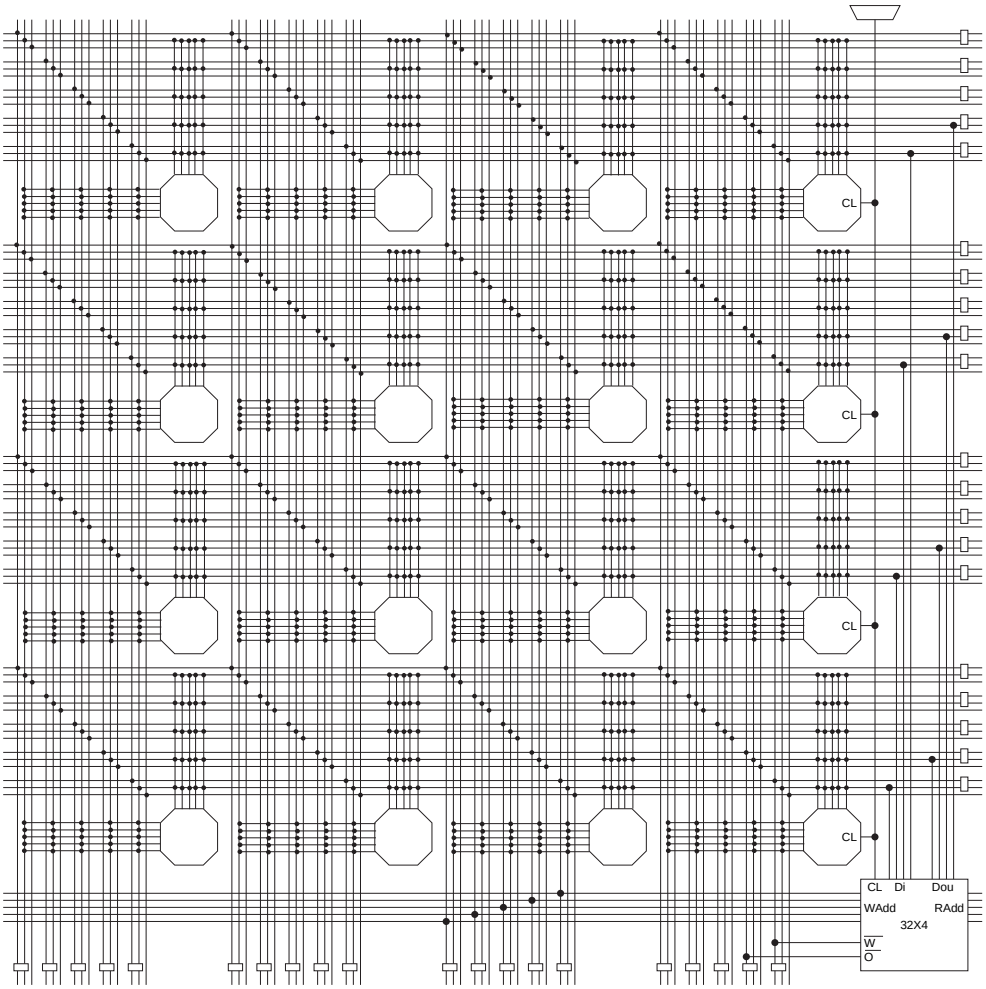
X = Diagonal Direct Connect or Bus
Y = Orthogonal Direct Connect or Bus
W = Bus Connection
Z = Bus Connection
FB = Internal Feedback

The core cell can be configured in several “modes”. The core cell flexibility makes the AT40K architecture well suited to most digital design application areas (see Figure 6).

RAM

32 x 4 Dual-Ported RAM blocks are dispersed throughout the array as shown in Figure 7. A four-bit Input Data Bus connects to four horizontal local buses distributed over four sector rows (plane 1). A four-bit Output Data Bus connects to four horizontal local buses distributed over four sector rows (plane 2). A five-bit Input-Address Bus connects to five vertical express buses in same column. A five-bit Output-Address Bus connects to five vertical express buses in same column. WAddr (Write Address) and RAddr (Read Address) alternate positions in horizontally aligned RAM blocks. For the left-most RAM blocks, RAddr is on the left and WAddr is on the right. For the right-most RAM blocks, WAddr is on the left and RAddr is tied off. For single-ported RAM, WAddr is the READ/WRITE address port and Din is the (bi-directional) data port. Right-most RAM blocks can be used only for single-ported memories. /WE & /OE connect to the vertical express buses in the same column. WAddr, RAddr, /WE and /OE connect to express buses that are full length at array edge.

Figure 7. RAM Connections (One Ram Block)

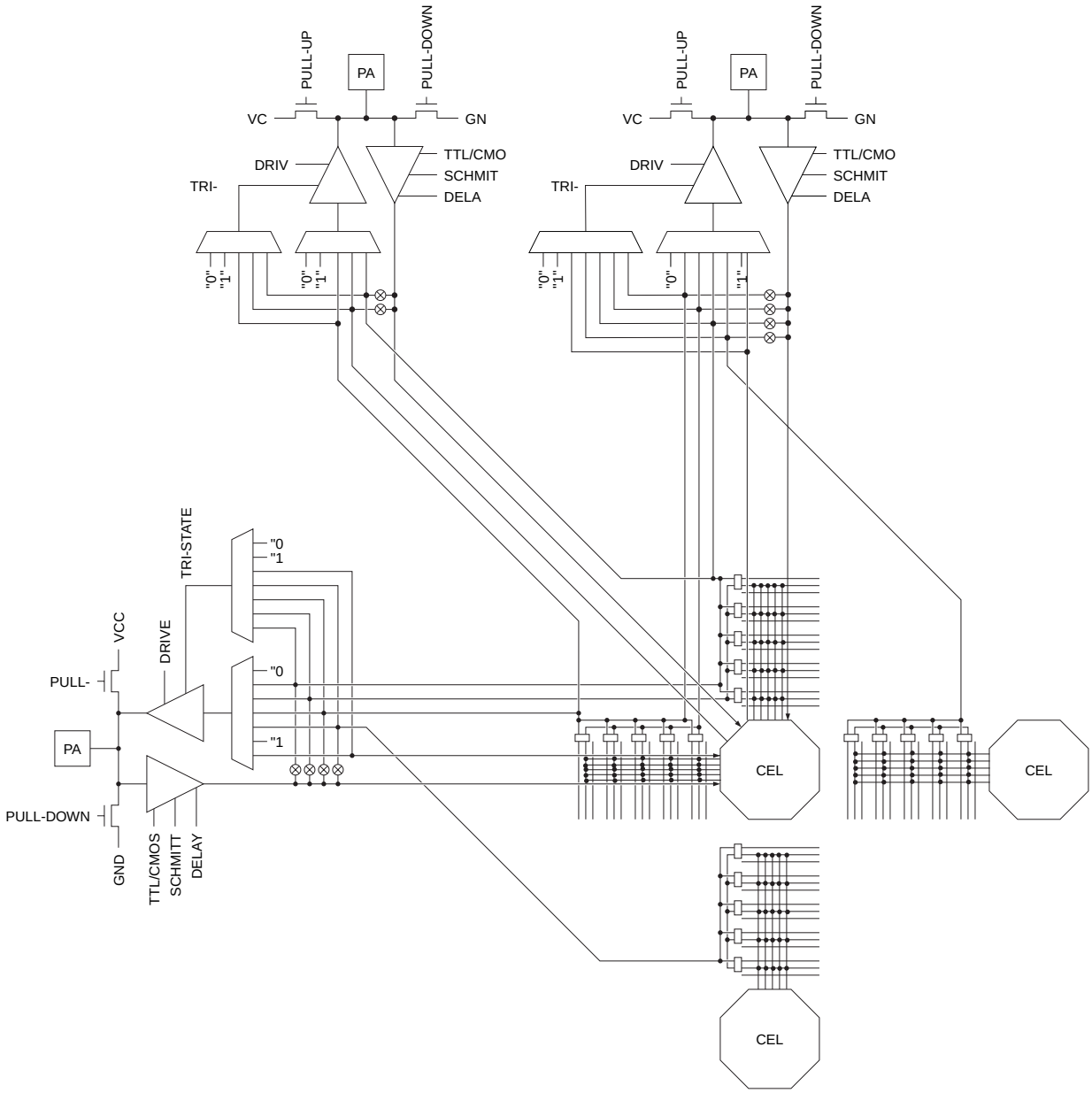


Clocking and Set/Reset

Each of 8 dedicated Global Clock buses is connected to a dual-use Global Clock pad (GCK1 - GCK8). An internal signal can be placed on a Global Clock bus by routing that signal to a Global Clock pad. Each column of the array has a Column Clock selected from one of the 8 Global Clock buses. The extreme-left Column Clock mux has two additional inputs from dual-use pins FCK1 & FCK2 to provide fast clocking to left-side I/O. The extreme-right Column Clock mux has two additional inputs from dual-use pins FCK3 & FCK4 to provide fast clocking to right-side I/O. Each sector column of 4 cells can be clocked from a (Plane 4) express bus or from the Column Clock. Clocking to the 4 cells can be disabled. The Plane 4 express bus used for clocking is half length at the array edge. The clock provided to each sector column of 4 cells can be either inverted or not inverted. The register in each cell is triggered on a rising clock edge. On power up, constant “0” is provided to each registers clock pins.

A dedicated Global Set/Reset bus can be driven by any USER I/O pad, except those used for clocking, Global or Fast. An internal signal can be placed on the Global Set/Reset bus by routing that signal to the pad programmed as the Global Set/Reset input. Global Set/Reset is distributed to each column of the array. Each sector column of 4 cells can be Set/Reset by a (Plane 5) express bus or by the Global Set/Reset. The Plane 5 express bus used for Set/Reset is half length at array edge. The Set/Reset provided to each sector column of 4 cells can be either inverted or not inverted. The function of the Set/Reset input of a register (either Set or Reset) is determined by a configuration bit in each cell. The Set/Reset input of a register is Active Low (logic 0). Setting or resetting of a register is asynchronous. On power up, a logic 1 (a high) is provided by each register, i.e., all registers are set at power up.

Figure 14. North/West Corner, (similar for NE/SE/SW corners)



Absolute Maximum Ratings - 5V Commercial/Industrial*

Symbol	Parameter	Conditions	Min	Max	Units
V_{CC}	Supply Voltage	With respect to GND	-0.5	7.0	V
V_I	DC Input Voltage(1)	With respect ot GND	-0.5	7.0	V
V_O	DC Output Voltaage	With respect ot GND	-0.5	7.0	V
T_{STG}	Storage Temperature		-65°C	+150°C	
T_J	Junction Temperature			+150°C	
T_L	Lead Temperature (Soldering, 10 sec.)			+250°C	
ESD		R_{ZAP} = 1.5K, C_{ZAP} = 100 pF		2000	V

Note: 1. Minimum voltage of -0.5V DC which may undershoot to -2.0V for pulses of less than 20 ns.

*NOTICE: Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC and AC Operating Range - 5V Operation

		AT40K05-2 AT40K10-2 AT40K20-2 AT40K40-2 Commercial	**AT40K05-2 AT40K10-2 AT40K20-2 AT40K40-2 Industrial**	**AT40K05-2 AT40K10-2 AT40K20-2 AT40K40-2 Military**
Operating Temperature (Case)		0°C - 70°C	-40°C - 85°C	-55°C - 125°C
V_{CC} Power Supply		5V ± 5%	5V ± 10%	5V ± 10%
Input Voltage Level (TTL)	High (V_{IHT})	2.0V - V_{CC}	2.0V - V_{CC}	2.0V - V_{CC}
	Low (V_{ILT})	0V - 0.8V	0V - 0.8V	0V - 0.8V
Input Voltage Level (CMOS)	High (V_{IHC})	70% - 100% V_{CC}	70% - 100% V_{CC}	70% - 100% V_{CC}
	Low (V_{ILC})	0 - 30% V_{CC}	0 - 30% V_{CC}	0 - 30% V_{CC}

DC Characteristics - 5V Operation - Commercial/Industrial/Military

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{IH}	High-Level Input Voltage	CMOS	70% V_{CC}			V
		TTL	2.0			V
V_{IL}	Low-Level Input Voltage	CMOS	-0.3		30% V_{CC}	V
		TTL	-0.3		0.8	V
V_{OH}	High-Level Output Voltage	I_{OH} = 6mA V_{CC} = V_{CC} min	4.0			V
		I_{OH} = 14mA V_{CC} = V_{CC} min	4.0			V
		I_{OH} = 20mA Comm. = 4.75V Ind./Military = 4.5V	4.0			V
V_{OL}	Low-Level Output Voltage	I_{OL} = -6mA Comm. = 4.75V Ind./Military = 4.5V			0.4	V
		I_{OL} = -14mA Comm. = 4.75V Ind./Military = 4.5V			0.4	V
		I_{OL} = -20mA Comm. = 4.75V Ind./Military = 4.5V			0.4	V
I_{IH}	High-Level Input Current	V_{IN} = V_{CC} max			10	µA
		With pulldown, V_{IN} = V_{CC}	125	250	500	µA
I_{IL}	Low-Level Input Current	V_{IN} = V_{SS}	-10			µA
		With pullup, V_{IN} = V_{SS}	-500	-250	-125	µA
I_{OZH}	High-Level Tristate Output leakage current	Without pulldown, V_{IN} = V_{CC}			10	µA
		With pulldown, V_{IN} = V_{CC}	125	250	500	µA
I_{OZL}	Low-Level Tristate Output leakage current	Without pullup, V_{IN} = V_{SS} max	-10			µA
		With pullup, V_{IN} = V_{SS} max	-500	-250	-125	µA
I_{CC}	Standby Current Consumption	Standby, unprogrammed		0.6	1	mA
C_{IN}	Input Capacitance	All pins			10	pF

Absolute Maximum Ratings - 3.3V Commercial/Industrial*

Symbol	Parameter	Conditions	Min	Max	Units
V_{CC}	Supply Voltage	With respect to GND	-0.5	7.0	V
V_I	DC Input Voltage(1)	With respect ot GND	-0.5	7.0	V
V_O	DC Output Voltaage	With respect ot GND	-0.5	7.0	V
T_{STG}	Storage Temperature		-65°C	+150°C	
T_J	Junction Temperature			+150°C	
T_L	Lead Temperature (Soldering, 10 sec.)			+250°C	
ESD		R_{ZAP} = 1.5K, C_{ZAP} = 100 pF		2000	V

Note: 1. Minimum voltage of -0.5V DC which may undershoot to -2.0V for pulses of less than 20 ns.

*NOTICE: Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC and AC Operating Range - 3.3V Operation

		AT40K05LV-4/3/2 AT40K10LV-4/3/2 AT40K20LV-4/3/2 AT40K40LV-4/3/2 Commercial	**AT40K05LV-4/3/2 AT40K10LV-4/3/2 AT40K20LV-4/3/2 AT40K40LV-4/3/2 Industrial**
Operating Temperature (Case)		0°C - 70°C	-40°C - 85°C
V_{CC} Power Supply		3.3V ± 0.3V	3.3V ± 0.3V
Input Voltage Level (CMOS)	High (V_{IHC})	70% - 100% V_{CC}	70% - 100% V_{CC}
	Low (V_{ILC})	0 - 30% V_{CC}	0 - 30% V_{CC}

AC Timing Characteristics - 3.3V Operation

Delays are based on fixed loads and are described in the notes.
Maximum times based on worst case: V_{CC} = 3.0V, temperature = 70°C
Minimum times based on best case: V_{CC} = 3.6V, temperature = 0°C
Max delays are the average of t_{PDLH} and t_{PDHL}.

All input IO characteristics measured from a V_{IH} of 50% of V_{DD} at the pad (CMOS threshold) to the internal V_{IH} of 50% of V_{DD}. All output IO characteristics are measured as the average of t_{PDLH} and t_{PDHL} to the pad V_{IH} of 50% of V_{DD}.

Cell Function	Parameter	Path	-3	Units	Notes
Repeaters					
Repeater	t_{PD}(max)	L -> E	2.2	ns	1 unit load
Repeater	t_{PD}(max)	E -> E	2.2	ns	1 unit load
Repeater	t_{PD}(max)	L -> L	2.2	ns	1 unit load
Repeater	t_{PD}(max)	E -> L	2.2	ns	1 unit load
Repeater	t_{PD}(max)	E -> IO	1.4	ns	1 unit load
Repeater	t_{PD}(max)	L -> IO	1.4	ns	1 unit load

All input IO characteristics measured from a V_{IH} of 50% of V_{DD} at the pad (CMOS threshold) to the internal V_{IH} of 50% of V_{DD}. All output IO characteristics are measured as the average of t_{PDLH} and t_{PDHL} to the pad V_{IH} of 50% of V_{DD}.

Cell Function	Parameter	Path	-3	Units	Notes
IO					
Input	t_{PD}(max)	pad -> x/y	1.9	ns	no extra delay
Input	t_{PD}(max)	pad -> x/y	5.8	ns	1 extra delay
Input	t_{PD}(max)	pad -> x/y	11.5	ns	2 extra delays
Input	t_{PD}(max)	pad -> x/y	17.4	ns	3 extra delays
Output, slow	t_{PD}(max)	x/y/E/L -> pad	9.1	ns	50pf load
Output, medium	t_{PD}(max)	x/y/E/L -> pad	7.6	ns	50pf load
Output, fast	t_{PD}(max)	x/y/E/L -> pad	6.2	ns	50pf load
Output, slow	t_{PZX}(max)	oe -> pad	9.5	ns	50pf load
Output, slow	t_{PXZ}(max)	oe -> pad	2.1	ns	50pf load
Output, medium	t_{PZX}(max)	oe -> pad	7.4	ns	50pf load
Output, medium	t_{PXZ}(max)	oe -> pad	2.7	ns	50pf load
Output, fast	t_{PZX}(max)	oe -> pad	5.9	ns	50pf load
Output, fast	t_{PXZ}(max)	oe -> pad	2.4	ns	50pf load

AT40K05	AT40K10	AT40K20	AT40K40	Left Side (Top to Bottom)										
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
			I/O63											W28
			I/O64											Y31
			I/O65										T24	Y30
			I/O66										U25	Y29
			GND											GND(1)
	I/O31	I/O43	I/O67							J5	38	256	T23	Y28
	I/O32	I/O44	I/O68							K1	39	255	V26	AA30
	VCC	VCC	VCC							VCC(1)	40	253	VCC(1)	VCC(1)
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
I/O21	I/O33	I/O45	I/O69	25	19	16	23	25	33	K2	41	252	U24	AA29
I/O22	I/O34	I/O46	I/O70	26	20	17	24	26	34	K3	42	251	V25	AB31
I/O23	I/O35	I/O47	I/O71				25	27	35	J6	43	250	V24	AB30
I/O24, FCK2	I/O36, FCK2	I/O48, FCK2	I/O72, FCK2				26	28	36	L1	44	249	U23	AB29
GND	GND	GND	GND				27	29	37	GND*	45	248	GND(1)	GND(1)
		I/O49	I/O73									247	Y26	AB28
		I/O50	I/O74									246	W25	AC30
	I/O37	I/O51	I/O75							L2	46	245	W24	AC29
	I/O38	I/O52	I/O76							K4	47	244	V23	AC28
			I/O77											
			I/O78											
			GND											GND(1)
														VCC(1)
			I/O79											AD31
			I/O80											AD30
	I/O39	I/O53	I/O81						38	L3	48	243	AA26	AD29
	I/O40	I/O54	I/O82						39	M1	49	242	Y25	AD28
I/O25	I/O41	I/O55	I/O83					30	40	K5	50	241	Y24	AE30
I/O26	I/O42	I/O56	I/O84					31	41	M2	51	240	AA25	AE29
		GND	GND										GND(1)	GND(1)
		VCC	VCC										VCC(1)	VCC(1)
		I/O57	I/O85									239	AB25	AF31
		I/O58	I/O86									238	AA24	AE28
			I/O87											AF30
			I/O88											AF29
I/O27	I/O43	I/O59	I/O89	27	21	18	28	32	42	L4	52	237	Y23	AG31
I/O28	I/O44	I/O60	I/O90		22	19	29	33	43	N1	53	236	AC26	AF28
			GND											GND(1)
			I/O91										AD26	AG30
			I/O92										AC25	AG29
I/O29	I/O45	I/O61	I/O93				30	34	44	M3	54	235	AA23	AH31
I/O30	I/O46	I/O62	I/O94				31	35	45	N2	55	234	AB24	AG28
I/O31 (/OTS)	I/O47 (/OTS)	I/O63 (/OTS)	I/O95 (/OTS)	28	23	20	32	36	46	K6	56	233	AD25	AH30

Note: 1. Pads labelled GND or VCC are internally bonded to Ground or VCC planes within the package. They have no direct connection to any specific package pin.

AT40K05	AT40K10	AT40K20	AT40K40	Left Side (Top to Bottom)										
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
I/O32, GCK2	I/O48, GCK2	I/O64, GCK2	I/O96, GCK2	29	24	21	33	37	47	P1	57	232	AC24	AJ30
M1	M1	M1	M1	30	25	22	34	38	48	N3	58	231	AB23	AH29
GND	GND	GND	GND	31	26	23	35	39	49	GND(1)	59	230	GND(1)	GND(1)
M0	M0	M0	M0	32	27	24	36	40	50	P2	60	229	AD24	AH28

AT40K05	AT40K10	AT40K20	AT40K40	Bottom Side (Left to Right)										
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
VCC	VCC	VCC	VCC	33	28	25	37	41	55	VCC*	61	228	VCC(1)	VCC(1)
M2	M2	M2	M2	34	29	26	38	42	56	M4	62	227	AC23	AJ28
I/O33, GCK3	I/O49, GCK3	I/O65, GCK3	I/O97, GCK3	35	30	27	39	43	57	R2	63	226	AE24	AK29
I/O34 (HDC)	I/O50 (HDC)	I/O66 (HDC)	I/O98 (HDC)	36	31	28	40	44	58	P3	64	225	AD23	AH27
I/O35	I/O51	I/O67	I/O99				41	45	59	L5	65	224	AC22	AK28
I/O36	I/O52	I/O68	I/O100				42	46	60	N4	66	223	AF24	AJ27
I/O37	I/O53	I/O69	I/O101		32	29	43	47	61	R3	67	222	AD22	AL28
I/O38 (LDC)	I/O54 (LDC)	I/O70 (LDC)	I/O102 (LDC)	37	33	30	44	48	62	P4	68	221	AE23	AH26
			GND											GND(1)
			I/O103											AK27
			I/O104											AJ26
			I/O105										AC21	AL27
			I/O106										AD21	AH25
		I/O71	I/O107									220	AE22	AK26
		I/O72	I/O108									219	AF23	AL26
		VCC	VCC										VCC(1)	VCC(1)
		GND	GND										GND(1)	GND(1)
I/O39	I/O55	I/O73	I/O109					49	63	K7	69	218	AD20	AH24
I/O40	I/O56	I/O74	I/O110					50	64	M5	70	217	AE21	AJ25
	I/O57	I/O75	I/O111						65	R4	71	216	AF21	AK25
	I/O58	I/O76	I/O112						66	N5	72	215	AC19	AJ24
			I/O113											AH23
			I/O114											AK24
														VCC(1)
			GND											GND(1)
			I/O115											
			I/O116											
	I/O59	I/O77	I/O117							P5	73	214	AD19	AL24
	I/O60	I/O78	I/O118							L6	74	213	AE20	AH22
		I/O79	I/O119									212	AF20	AJ23
		I/O80	I/O120									211	AC18	AK23
GND	GND	GND	GND				45	51	67	GND(1)	75	210	GND(1)	GND(1)

Note: 1. Pads labelled GND or VCC are internally bonded to Ground or VCC planes within the package. They have no direct connection to any specific package pin.

AT40K05	AT40K10	AT40K20	AT40K40	Bottom Side (Left to Right)										
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
I/O41	I/O61	I/O81	I/O121				46	52	68	R5	76	209	AD18	AJ22
I/O42	I/O62	I/O82	I/O122				47	53	69	M6	77	208	AE19	AK22
I/O43	I/O63	I/O83	I/O123	38	34	31	48	54	70	N6	78	207	AC17	AL22
I/O44	I/O64	I/O84	I/O124	39	35	32	49	55	71	P6	79	206	AD17	AJ21
	VCC	VCC	VCC							VCC(1)	80	204	VCC(1)	VCC(1)
	I/O65	I/O85	I/O125						72	R6	81	203	AE18	AH20
	I/O66	I/O86	I/O126						73	M7	82	202	AF18	AK21
			GND											GND(1)
			I/O127											AJ20
			I/O128											AH19
			I/O129										AC16	AK20
			I/O130										AD16	AJ19
		I/O87	I/O131									201	AE17	AL20
		I/O88	I/O132									200	AE16	AH18
		GND	GND								83		GND(1)	GND(1)
			VCC										VCC(1)	VCC(1)
		I/O89	I/O133									199	AF16	AK19
		I/O90	I/O134									198	AC15	AJ18
	I/O67	I/O91	I/O135							N7	84	197	AD15	AL19
	I/O68	I/O92	I/O136							P7	85	196	AE15	AK18
I/O45	I/O69	I/O93	I/O137		36	33	50	56	74	R7	86	195	AF15	AH17
I/O46	I/O70	I/O94	I/O138		37	34	51	57	75	L7	87	194	AD14	AJ17
			GND											GND(1)
			I/O139											
			I/O140											
			I/O141											AK17
			I/O142											AL17
I/O47 (D15)	I/O71 (D15)	I/O95 (D15)	I/O143 (D15)	40	38	35	52	58	76	N8	88	193	AE14	AJ16
I/O48 (INIT)	I/O72 (INIT)	I/O96 (INIT)	I/O144 (INIT)	41	39	36	53	59	77	P8	89	192	AF14	AK16
VCC	VCC	VCC	VCC	42	40	37	54	60	78	VCC(1)	90	191	VCC(1)	VCC(1)
GND	GND	GND	GND	43	41	38	55	61	79	GND(1)	91	190	GND(1)	GND(1)
I/O49 (D14)	I/O73 (D14)	I/O97 (D14)	I/O145 (D14)	44	42	39	56	62	80	L8	92	189	AE13	AL16
I/O50 (D13)	I/O74 (D13)	I/O98 (D13)	I/O146 (D13)	45	43	40	57	63	81	P9	93	188	AC13	AH15
			I/O147											AL15
			I/O148											AJ15
			I/O149											
			I/O150											
			GND											GND(1)
I/O51	I/O75	I/O99	I/O151		44	41	58	64	82	R9	94	187	AD13	AK15
I/O52	I/O76	I/O100	I/O152		45	42	59	65	83	N9	95	186	AF12	AJ14
	I/O77	I/O101	I/O153						84	M9	96	185	AE12	AH14
	I/O78	I/O102	I/O154						85	L9	97	184	AD12	AK14
		I/O103	I/O155									183	AC12	AL13

Note: 1. Pads labelled GND or VCC are internally bonded to Ground or VCC planes within the package. They have no direct connection to any specific package pin.

AT40K05	AT40K10	AT40K20	AT40K40	Bottom Side (Left to Right)										
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
			I/O186										AC6	AL4
			GND											GND(1)
			I/O187											AH6
			I/O188											AJ5
I/O61	I/O93	I/O125	I/O189				67	75	97	P13	115	158	AD5	AK4
I/O62	I/O94	I/O126	I/O190				68	76	98	K10	116	157	AE3	AH5
I/O63 (D8)	I/O95 (D8)	I/O127 (D8)	I/O191 (D8)	50	50	47	69	77	99	R14	117	156	AD4	AK3
I/O64, GCK4	I/O96, GCK4	I/O128, GCK4	I/O192 ,GCK4	51	51	48	70	78	100	N13	118	155	AC5	AJ4
GND	GND	GND	GND	52	52	49	71	79	101	GND(1)	119	154	GND(1)	GND(1)
/CON	/CON	/CON	/CON	53	53	50	72	80	103	P14	120	153	AD3	AH4

AT40K05	AT40K10	AT40K20	AT40K40	Right Side (Bottom to Top)										
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
VCC	VCC	VCC	VCC	54	54	51	73	81	106	VCC(1)	121	152	VCC(1)	VCC(1)
/RESET	/RESET	/RESET	/RESET	55	55	52	74	82	108	M12	122	151	AC4	AH3
I/O65 (D7)	I/O97 (D7)	I/O129 (D7)	I/O193 (D7)	56	56	53	75	83	109	P15	123	150	AD2	AJ2
I/O66, GCK5	I/O98, GCK5	I/O130, GCK5	I/O194, GCK5	57	57	54	76	84	110	N14	124	149	AC3	AG4
I/O67	I/O99	I/O131	I/O195				77	85	111	L11	125	148	AB4	AG3
I/O68	I/O100	I/O132	I/O196				78	86	112	M13	126	147	AD1	AH2
			I/O197										AB3	AH1
			I/O198										AC2	AF4
			GND											GND(1)
	I/O101	I/O133	I/O199							N15	127	146	AA4	AF3
	I/O102	I/O134	I/O200							M14	128	145	AA3	AG2
			I/O201											AG1
			I/O202											AE4
		I/O135	I/O203									144	AB2	AE3
		I/O136	I/O204									143	AC1	AF2
		VCC	VCC										VCC(1)	VCC(1)
		GND	GND										GND(1)	GND(1)
I/O69 (D6)	I/O103 (D6)	I/O137 (D6)	I/O205 (D6)	58	58	55	79	87	113	J10	129	142	Y3	AF1
I/O70	I/O104	I/O138	I/O206		59	56	80	88	114	L12	130	141	AA2	AD4
I/O71	I/O105	I/O139	I/O207					89	115	M15	131	140	AA1	AD3
I/O72	I/O106	I/O140	I/O208					90	116	L13	132	139	W4	AE2
			I/O209											AD2
			I/O210											AC4
														VCC(1)
			GND											GND(1)

Note: 1. Pads labelled GND or VCC are internally bonded to Ground or VCC planes within the package. They have no direct connection to any specific package pin.

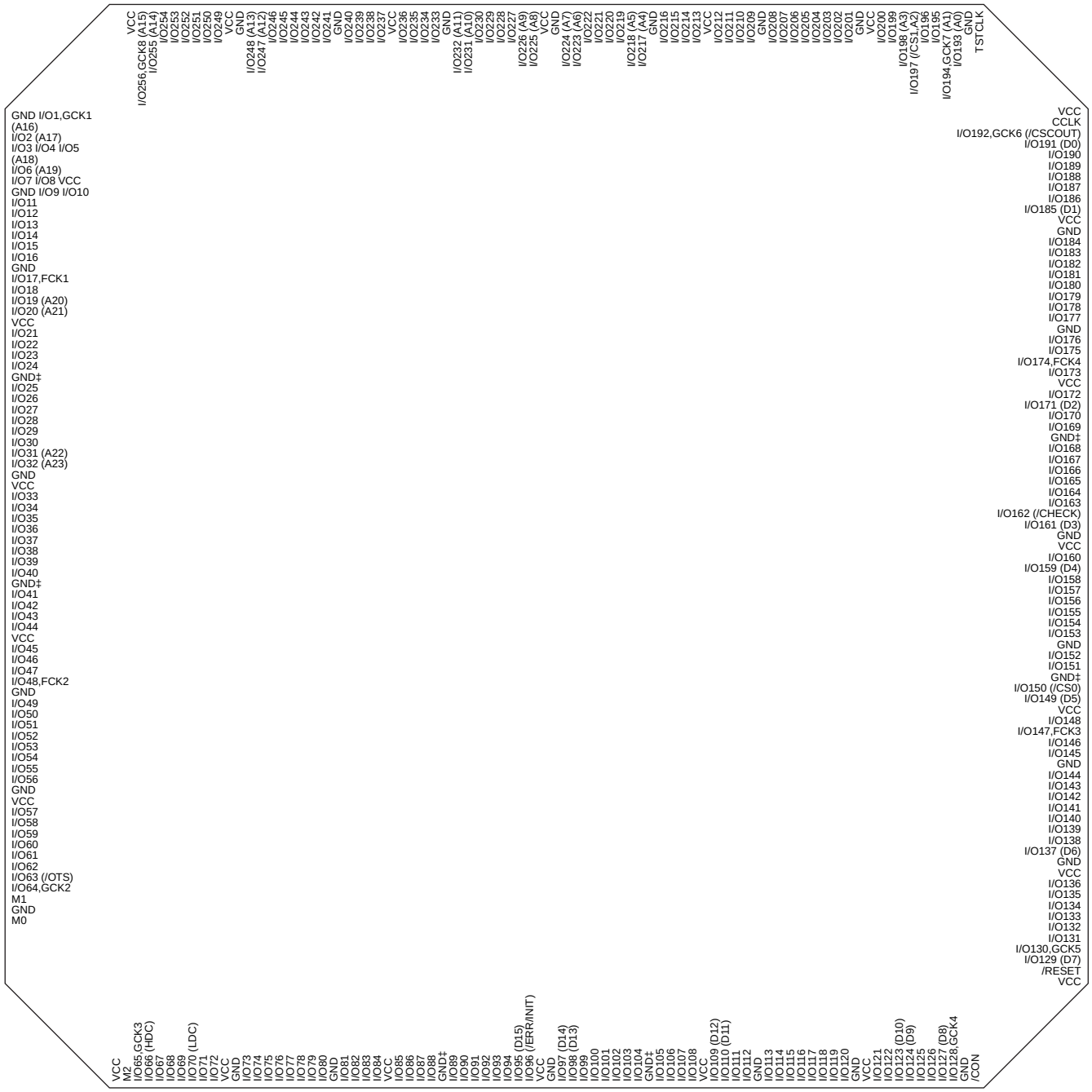
AT40K05	AT40K10	AT40K20	AT40K40	Right Side (Bottom to Top)										
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
			I/O211											
			I/O212											
	I/O107	I/O141	I/O213						117	L14	133	138	W3	AC3
	I/O108	I/O142	I/O214						118	K11	134	137	Y2	AD1
		I/O143	I/O215									136	Y1	AC2
		I/O144	I/O216									135	V4	AB4
GND	GND	GND	GND				81	91	119	GND(1)	135	134	GND(1)	GND(1)
	I/O109	I/O145	I/O217							L15	136	133	V3	AB3
	I/O110	I/O146	I/O218							K12	137	132	W2	AB2
I/O73, FCK3	I/O111, FCK3	I/O147, FCK3	I/O219, FCK3				82	92	120	K13	138	131	U4	AB1
I/O74	I/O112	I/O148	I/O220				83	93	121	K14	139	130	U3	AA3
	VCC	VCC	VCC							VCC(1)	140	129	VCC(1)	VCC(1)
I/O75 (D5)	I/O113 (D5)	I/O149 (D5)	I/O221 (D5)	59	60	57	84	94	122	K15	141	127	V2	AA2
I/O76 (CS0)	I/O114 (CS0)	I/O150 (CS0)	I/O222 (CS0)	60	61	58	85	95	123	J12	142	126	V1	Y2
			GND											GND(1)
			I/O223										T4	Y4
			I/O224										T3	Y3
			I/O225											Y1
			I/O226											W1
		I/O151	I/O227									125	U2	W4
		I/O152	I/O228									124	T2	W3
		GND	GND								143		GND(1)	GND(1)
			VCC										VCC(1)	VCC(1)
			I/O229											W2
			I/O230											V2
		I/O153	I/O231									123	T1	V4
		I/O154	I/O232									122	R4	V3
	I/O115	I/O155	I/O233						124	J13	144	121	R3	U1
	I/O116	I/O156	I/O234						125	J14	145	120	R2	U2
			GND											GND(1)
I/O77	I/O117	I/O157	I/O235		62	59	86	96	126	J15	146	119	R1	U4
I/O78	I/O118	I/O158	I/O236		63	60	87	97	127	J11	147	118	P3	U3
			I/O237											
			I/O238											
I/O79(D4)	I/O119(D4)	I/O159(D4)	I/O239(D4)	61	64	61	88	98	128	H13	148	117	P2	T1
I/O80	I/O120	I/O160	I/O240	62	65	62	89	99	129	H14	149	116	P1	T2
VCC	VCC	VCC	VCC	63	66	63	90	100	130	VCC(1)	150	115	VCC(1)	VCC(1)
GND	GND	GND	GND	64	67	64	91	101	131	GND(1)	151	114	GND(1)	GND(1)
I/O81 (D3)	I/O121 (D3)	I/O161 (D3)	I/O241 (D3)	65	68	65	92	102	132	H12	152	113	N2	T3
I/O82 (/CHECK)	I/O122 (/CHECK)	I/O162 (/CHECK)	I/O242 (/CHECK)	66	69	66	93	103	133	H11	153	112	N4	R1
			I/O243											

Note: 1. Pads labelled GND or VCC are internally bonded to Ground or VCC planes within the package. They have no direct connection to any specific package pin.

AT40K05	AT40K10	AT40K20	AT40K40	Top Side (Right to Left)										
128 I/O	192 I/O	256 I/O	384 I/O	PC84	RQ100	VQ100	TQ144	PQ160	PQ208	BG225	PQ240	PQ304	BG352	BG432
			GND											GND(1)
			I/O331											
			I/O332											
			I/O333											A15
			I/O334											C16
I/O111 (A6)	I/O167 (A6)	I/O223 (A6)	I/O335 (A6)	83	89	86	125	139	180	C8	209	41	A13	B16
I/O112 (A7)	I/O168 (A7)	I/O224 (A7)	I/O336 (A7)	84	90	87	126	140	181	B8	210	40	B14	A16
GND	GND	GND	GND	1	91	88	127	141	182	GND(1)	211	39	GND(1)	GND(1)
VCC	VCC	VCC	VCC	2	92	89	128	142	183	VCC(1)	212	38	VCC(1)	VCC(1)
I/O113 (A8)	I/O169 (A8)	I/O225 (A8)	I/O337 (A8)	3	93	90	129	143	184	E8	213	37	D14	D17
I/O114 (A9)	I/O170 (A9)	I/O226 (A9)	I/O338 (A9)	4	94	91	130	144	185	B7	214	36	C14	A17
			I/O339											C17
			I/O340											B17
			I/O341											
			I/O342											
			GND											GND(1)
I/O115	I/O171	I/O227	I/O343		95	92	131	145	186	A7	215	35	A15	C18
I/O116	I/O172	I/O228	I/O344		96	93	132	146	187	C7	216	34	B15	D18
	I/O173	I/O229	I/O345						188	D7	217	33	C15	B18
	I/O174	I/O230	I/O346						189	E7	218	32	D15	A19
I/O117 (A10)	I/O175 (A10)	I/O231 (A10)	I/O347 (A10)	5	97	94	133	147	190	A6	220	31	A16	B19
I/O118 (A11)	I/O176 (A11)	I/O232 (A11)	I/O348 (A11)	6	98	95	134	148	191	B6	221	30	B16	C19
			VCC										VCC(1)	VCC(1)
		GND	GND										GND(1)	GND(1)
		I/O233	I/O349									29	C16	D19
		I/O234	I/O350									28	B17	A20
			I/O351										D16	B20
			I/O352										A18	C20
			I/O353											B21
			I/O354											D20
			GND											GND(1)
		I/O235	I/O355									27	C17	C21
		I/O236	I/O356									26	B18	A22
	VCC	VCC	VCC							VCC(1)	222	25	VCC(1)	VCC(1)
	I/O177	I/O237	I/O357							C6	223	23	C18	B22
	I/O178	I/O238	I/O358							F7	224	22	D17	C22
I/O119	I/O179	I/O239	I/O359				135	149	192	A5	225	21	A20	B23
I/O120	I/O180	I/O240	I/O360				136	150	193	B5	226	20	B19	A24

Note: 1. Pads labelled GND or VCC are internally bonded to Ground or VCC planes within the package. They have no direct connection to any specific package pin.

Figure 15. AT40K20 Pad Ring



AT40K20 Ordering Information

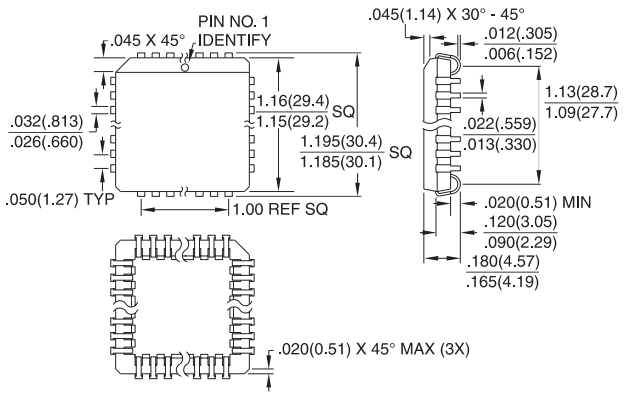
Usable Gates	Speed Grade (ns)	Ordering Code	Package	Operation Range
20,000-30,000	2	AT40K20-2AJC	84J	5V Commercial
		AT40K20-2AQC	100Q	(0°C to 70°C)
		AT40K20-2BQC	144Q	
		AT40K20-2CQC	160Q	
		AT40K20-2DQC	208Q	
		AT40K20-2EQC	240Q	
		AT40K20-2FQC	304Q	
		AT40K20-2BGC	352G	
		AT40K20-2AGC	225G	
20,000-30,000	2	AT40K20-2AJI	84J	5V Industrial
		AT40K20-2BQI	144Q	(-40°C to 85°C)
		AT40K20-2CQI	160Q	
		AT40K20-2DQI	208Q	
		AT40K20-2EQI	240Q	
		AT40K20-2FQI	304Q	
		AT40K20-2BGI	352G	
		AT40K20-2AGI	225G	

Usable Gates	Speed Grade (ns)	Ordering Code	Package	Operation Range
20,000-30,000	3	AT40K20LV-2AJC	84J	3.3V Commercial
		AT40K20LV-2AQC	100Q	(0°C to 20°C)
		AT40K20LV-2BQC	144Q	
		AT40K20LV-2CQC	160Q	
		AT40K20LV-2DQC	208Q	
		AT40K20LV-2EQC	240Q	
		AT40K20LV-2FQC	304Q	
		AT40K20LV-2BGC	352G	
		AT40K20LV-2AGC	225G	

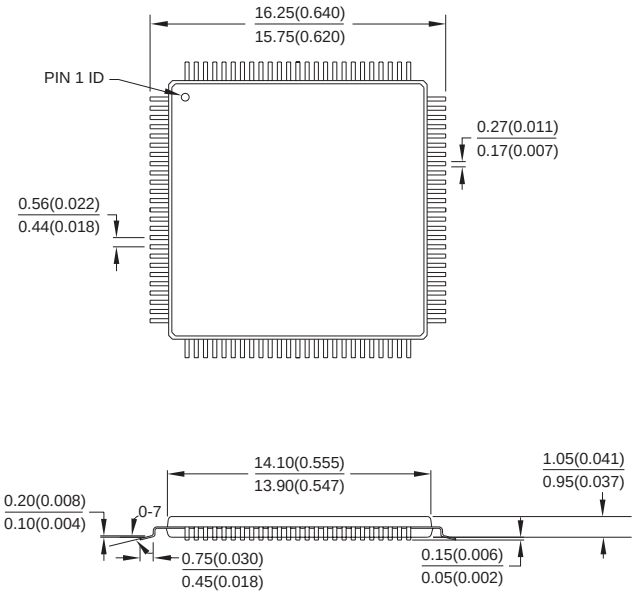
Package Type	
84J	84-lead, Plastic J-Leaded Chip Carrier (PLCC)
100Q	100-lead, Very Thin (1.0 mm) Plastic Gull Wing Quad Flat Package (VQFP)
144Q	144-lead, Thin (1.4 mm) Plastic Gull Wing Quad Flat Package (TQFP)
160Q	160-lead, Plastic Gull Wing Quad Flat Package (PQFP)
208Q	208-lead, Plastic Gull Wing Quad Flat Package (PQFP)
225G	225-lead, Ball Grid Array Package (BGA)
240Q	240-lead, Plastic Gull Wing Quad Flat Package (PQFP)
304Q	304-lead, Plastic Gull Wing Quad Flat Package (PQFP)
352G	352-ball, Ball Grid Array Package (BGA)
432G	432-ball, Ball Grid Array Package (BGA)

Packaging Information

84J, 84-lead, Plastic J-Leaded Chip Carrier (PLCC)
Dimensions in Inches and (Millimeters)
JEDEC STANDARD MS-018 AF

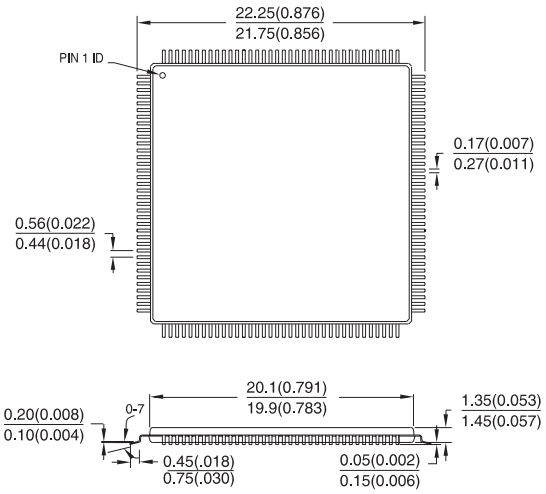


100Q, 100-lead, Plastic Gull Wing Quad Flat Package (VQFP)
Dimensions in Millimeters and (Inches)*



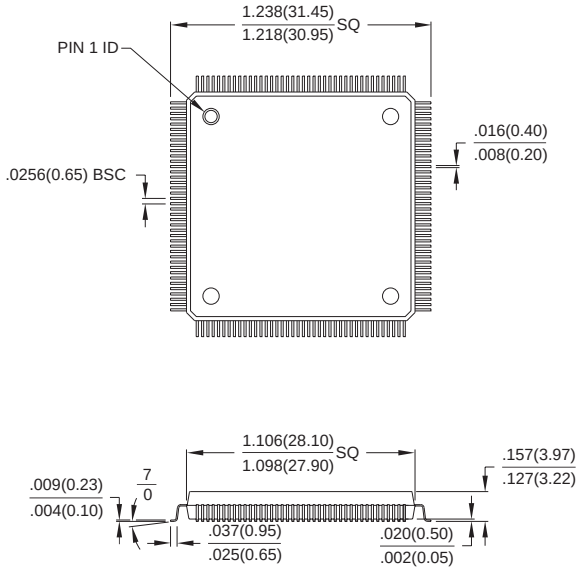
*Controlling dimension: millimeters

144Q, 144-lead, Plastic Gull Wing Quad Flat Package (TQFP)
Dimensions in Millimeters and (Inches)*



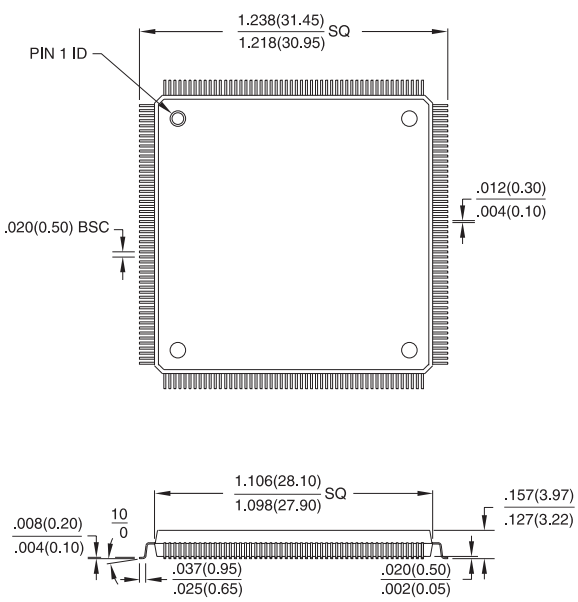
*Controlling dimension: millimeters

160Q, 160-lead, Plastic Gull Wing Quad Flat Package (PQFP)
Dimensions in (Millimeters) and Inches



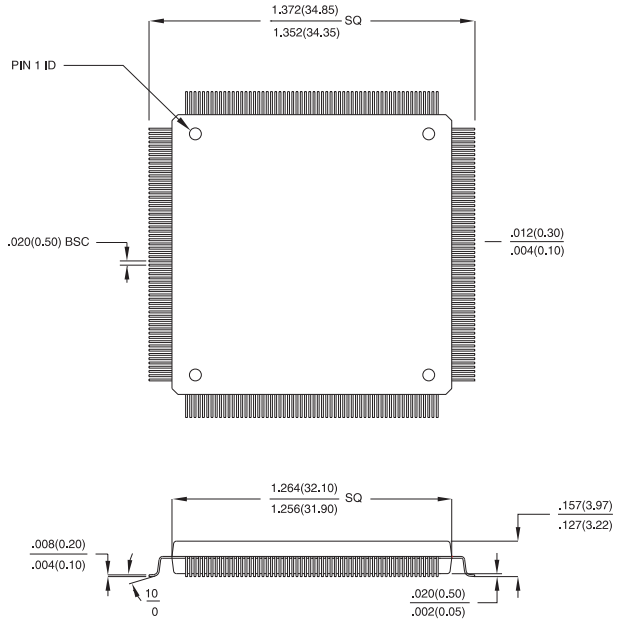
Packaging Information

208Q, 208-lead, Plastic Gull Wing Quad Flat Package (PQFP)
Dimensions in (Millimeters) and Inches



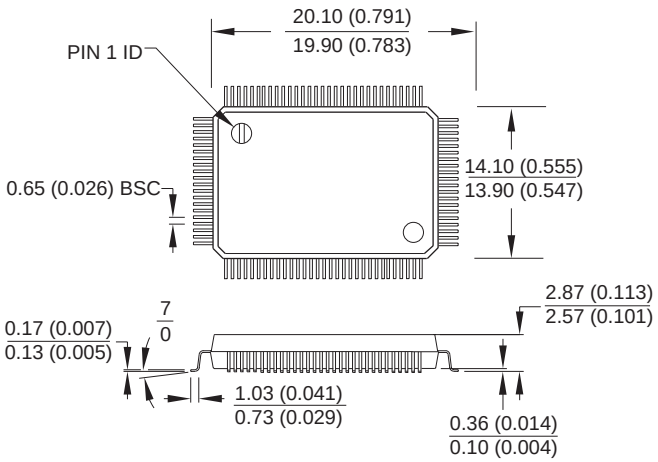
*Controlling dimension: millimeters

240Q, 240-lead, Plastic Gull Wing Quad Flat Package (PQFP)
Dimensions in (Millimeters) and Inches



*Controlling dimension: millimeters

100RQ, 100-lead, Rectangular Plastic Gull Wing Quad Flat Pack (RQFP)
Dimensions in Millimeters and (Inches)*



*Controlling dimension: millimeters

304Q, 304-lead, Plastic Gull Wing Quad Flat Pack (PQFP)
Dimensions in (Millimeters) and Inches