MOTOROLA
Freescale Semiconductor, Inc.
MC9S12C-FamilyPP
Rev. 3, 12-May-04

SEMICONDUCTOR
TECHNICAL DATA

MC9S12C-Family

Freescale Semiconductor, Inc.

Product Proposal
16-Bit Microcontroller

Based on Motorola's market-leading flash technology, members of the MC9S12C-Family deliver the power and flexibility of our 16 Bit core (CPU12) family to a whole new range of cost and space sensitive, general purpose Industrial and Automotive network applications. MC9S12C-Family members are comprised of standard on-chip peripherals including a 16-bit central processing unit (CPU12), up to 128K bytes of Flash EEPROM or ROM, up to 4K bytes of RAM, an asynchronous serial communications interface (SCI), a serial peripheral interface (SPI), an 8-channel 16-bit timer module (TIM), a 6-channel 8-bit Pulse Width Modulator (PWM), an 8-channel, 10-bit analog-to-digital converter (ADC) and up to one CAN 2.0 A, B software compatible module (MSCAN12). The MC9S12C-Family has full 16-bit data paths throughout. The inclusion of a PLL circuit allows power consumption and performance to be adjusted to suit operational requirements. In addition to the I/O ports available in each module, up to 10 dedicated I/O port bits are available with Wake-Up capability from STOP or WAIT mode. The MC9S12C-Family is available in 48, 52 and 80 pin QFP packages, with the 80 Pin version pin compatible to the HCS12 B and D- Family derivatives.

The C-Family includes ROM versions MC3S12C128/96/64/32/16 of all devices which provide a further cost reduction path for applications with high volume and stable code.

Features

- **16-bit HCS12 CORE**
  — HCS12 CPU
  — MMC (memory map and interface)
  — INT (interrupt control)
  — BDM (background debug mode)
  — DBG12 (enhanced debug12 module including breakpoints and change-of-flow trace buffer)
  — Multiplexed Expansion Bus (available only in 80 pin package version)

- **16-bit HCS12 CPU**
  — Upward compatible with M68HC11 instruction set
  — Interrupt stacking and programmer's model identical to M68HC11
  — Instruction queue
  — Enhanced indexed addressing

- **Wake-up interrupt inputs**
  — Up to 10-port bits available for wake up interrupt function

- **Memory options**
  — 16K, 32K, 64K, 96K and 128K Byte Flash EEPROM (erasable in 512-byte sectors) or
  — 16K, 32K, 64K, 96K and 128K Byte ROM
  — 2K and 4K Byte RAM

- **Analog-to-Digital Converters**
  — One 8-channel module with 10-bit resolution.
  — External conversion trigger capability

- **Up to one 1M bit per second, CAN 2.0 A, B software compatible modules**
  — Five receive and three transmit buffers

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— Flexible identifier filter programmable as 2 x 32 bit, 4 x 16 bit or 8 x 8 bit
— Four separate interrupt channels for receive, transmit, error and wake-up
— Low-pass filter wake-up function
— Loop-back for self test operation

• **Timer Module (TIM)**
— 16-bit Counter with 7-bit Prescaler
— 8 programmable input capture or output compare channels
— Simple PWM Mode
— Modulo Reset of Timer Counter
— 16-Bit Pulse Accumulator
— External Event Counting
— Gated Time Accumulation

• **6 PWM channels**
— Programmable period and duty cycle
— 8-bit 6-channel or 16-bit 3-channel
— Separate control for each pulse width and duty cycle
— Center-aligned or left-aligned outputs
— Programmable clock select logic with a wide range of frequencies
— Fast emergency shutdown input

• **Serial interfaces**
— One asynchronous serial communications interface (SCI)
— One synchronous serial peripheral interface (SPI)

• **CRG (Clock Reset Generator Module)**
— Windowed COP watchdog,
— Real time interrupt,
— Clock monitor,
— Clock generation
— Reset Generation
— Phase-locked loop clock frequency multiplier
— Limp home mode in absence of external clock
— Low power 0.5 to 16 MHz crystal oscillator reference clock

• **Operation frequency**
— 32MHz equivalent to 16MHz Bus Speed for single chip
— 32MHz equivalent to 16MHz Bus Speed in expanded bus modes
— Option: 50MHz equivalent to 25MHz Bus Speed

• **Internal 2.5V Regulator**
— Supports an input voltage range from 3.3V-10% to 5.5V
— Low power mode capability
— Includes low voltage reset (LVR) circuitry
— Includes low voltage interrupt (LVI) circuitry

• **48-Pin LQFP, 52-Pin LQFP or 80-Pin QFP package**
— Up to 58 I/O lines with 5V input and drive capability
— Up to 2 dedicated 5V input only lines (IRQ, XIRQ)
— 5V A/D converter inputs and 5V I/O

• **Development support**
— Single-wire background debug™ mode (BDM)
— On-chip hardware breakpoints
— Enhanced DBG12 debug features

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Table 1 List of MC9S12C-Family members

Flash	ROM	RAM	Package	Device	CAN	SCI	SPI	A/D	PWM	Timer	I/O
128K	0	4K	48LQFP	MC9S12C128	1	1	1	8ch	6ch	8ch	31
			52LQFP	MC9S12C128	1	1	1	8ch	6ch	8ch	35
			80QFP	MC9S12C128	1	1	1	8ch	6ch	8ch	60
96K	0	4K	48LQFP	MC9S12C96	1	1	1	8ch	6ch	8ch	31
			52LQFP	MC9S12C96	1	1	1	8ch	6ch	8ch	35
			80QFP	MC9S12C96	1	1	1	8ch	6ch	8ch	60
64K	0	4K	48LQFP	MC9S12C64	1	1	1	8ch	6ch	8ch	31
			52LQFP	MC9S12C64	1	1	1	8ch	6ch	8ch	35
			80QFP	MC9S12C64	1	1	1	8ch	6ch	8ch	60
32K	0	2K	48LQFP	MC9S12C32	1	1	1	8ch	6ch	8ch	31
			52LQFP	MC9S12C32	1	1	1	8ch	6ch	8ch	35
			80QFP	MC9S12C32	1	1	1	8ch	6ch	8ch	60
32K	0	2K	48LQFP	MC9S12GC32	0	1	1	8ch	6ch	8ch	31
			52LQFP	MC9S12GC32	0	1	1	8ch	6ch	8ch	35
16K	0	2K	48LQFP	MC9S12GC16	0	1	1	8ch	6ch	8ch	31
			52LQFP	MC9S12GC16	0	1	1	8ch	6ch	8ch	35
0	128K	4K	48LQFP	MC3S12C128	1	1	1	8ch	6ch	8ch	31
			52LQFP	MC3S12C128	1	1	1	8ch	6ch	8ch	35
			80QFP	MC3S12C128	1	1	1	8ch	6ch	8ch	60
0	96K	4K	48LQFP	MC3S12C96	1	1	1	8ch	6ch	8ch	31
			52LQFP	MC3S12C96	1	1	1	8ch	6ch	8ch	35
			80QFP	MC3S12C96	1	1	1	8ch	6ch	8ch	60
0	64K	4K	48LQFP	MC3S12C64	1	1	1	8ch	6ch	8ch	31
			52LQFP	MC3S12C64	1	1	1	8ch	6ch	8ch	35
			80QFP	MC3S12C64	1	1	1	8ch	6ch	8ch	60
0	32K	2K	48LQFP	MC3S12C32	1	1	1	8ch	6ch	8ch	31
			52LQFP	MC3S12C32	1	1	1	8ch	6ch	8ch	35
			80QFP	MC3S12C32	1	1	1	8ch	6ch	8ch	60
0	32K	2K	48LQFP	MC3S12GC32	0	1	1	8ch	6ch	8ch	31
			52LQFP	MC3S12GC32	0	1	1	8ch	6ch	8ch	35
0	16K	2K	48LQFP	MC9S12GC16	0	1	1	8ch	6ch	8ch	31
			52LQFP	MC9S12GC16	0	1	1	8ch	6ch	8ch	35

• **Pin out explanations:**
   — I/O is the sum of ports capable to act as digital input or output.

   For 80 Pin Versions:
           Port A = 8, B = 8, E = 6 + 2 input only, J = 2, M = 6, P = 8, S = 4, T = 8, PAD = 8.
           12 inputs provide Interrupt capability (P= 8, J = 2, IRQ, XIRQ)
   For 52 Pin Versions:
           Port A = 3, B = 1, E = 2 + 2 input only, M = 6, P = 3, S = 2, T = 8, PAD = 8.
           5 inputs provide Interrupt capability (P= 3, IRQ, XIRQ)
   For 48 Pin Versions:
           Port A = 1, B = 1, E = 2 + 2 input only, M = 6, P = 1, S = 2, T = 8, PAD = 8.
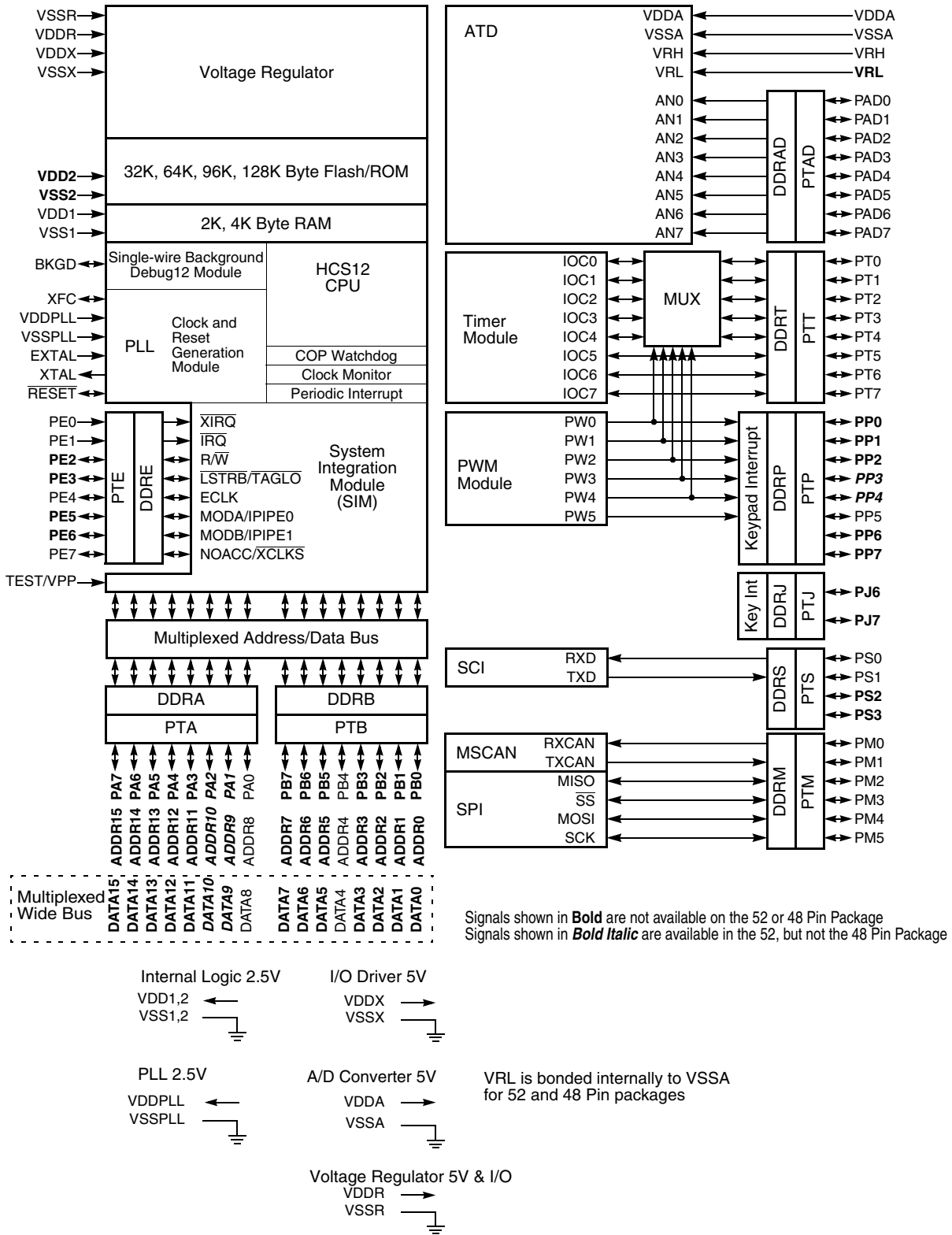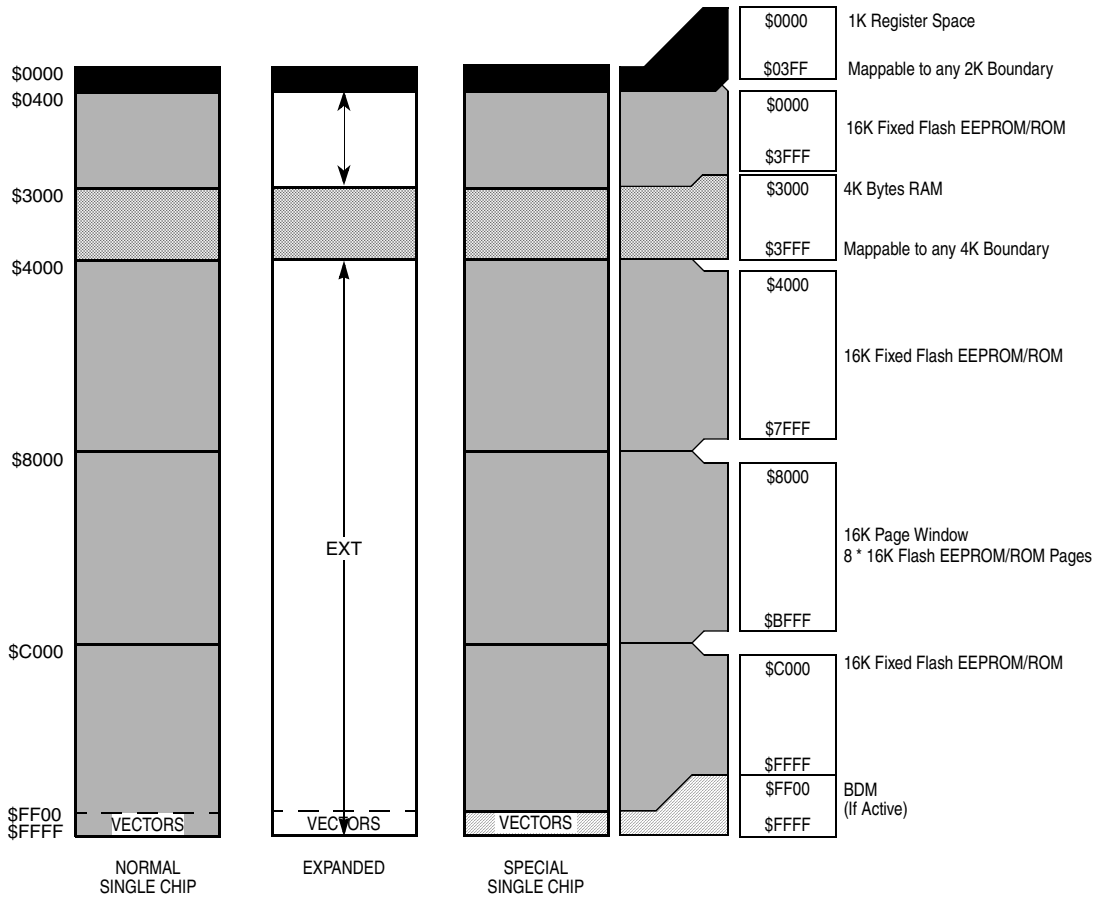   3 inputs provide Interrupt capability (P= 1, IRQ, XIRQ)
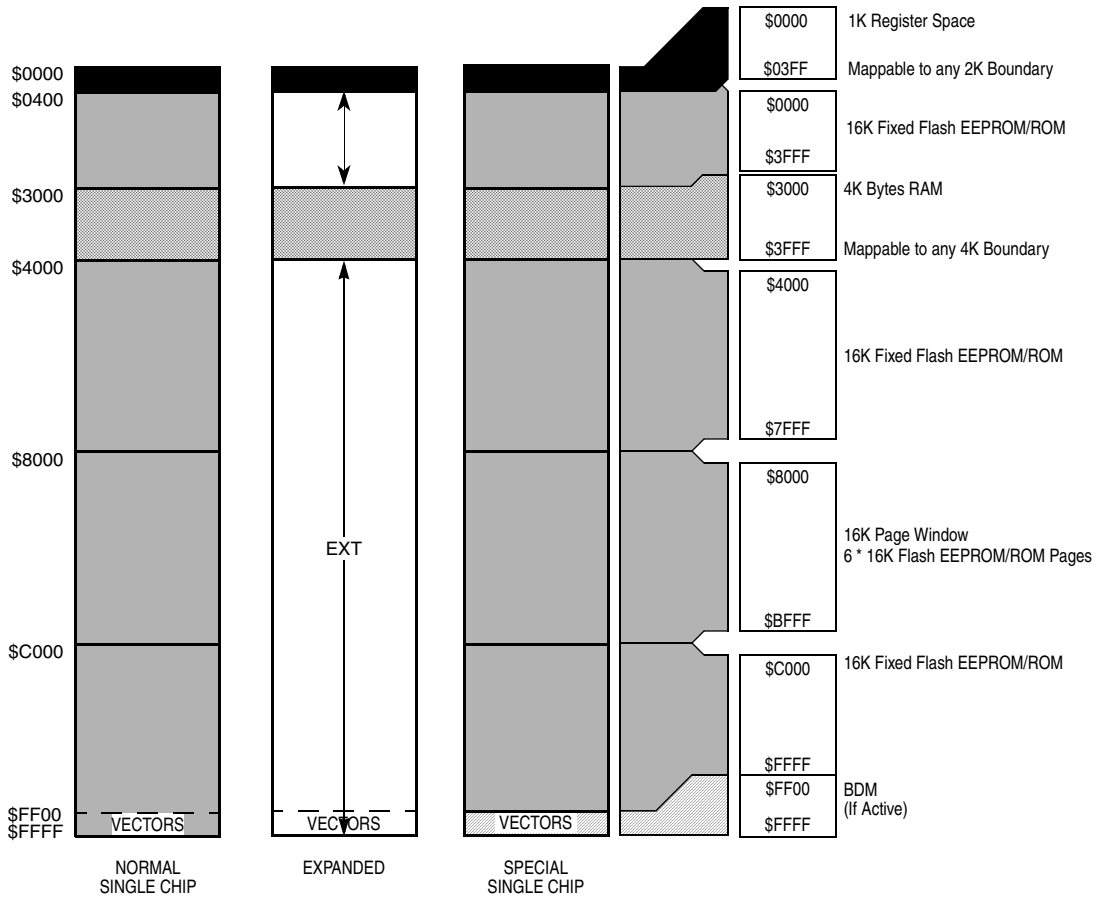
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Figure 1 Block Diagram

The figure shows a useful map, which is not the map out of reset. After reset the map is:

$0000 - $03FF: Register Space
$0000 - $0FFF: 4K RAM (only 3K visible $0400 - $0FFF)

Flash Erase Sector Size is 1024 Bytes
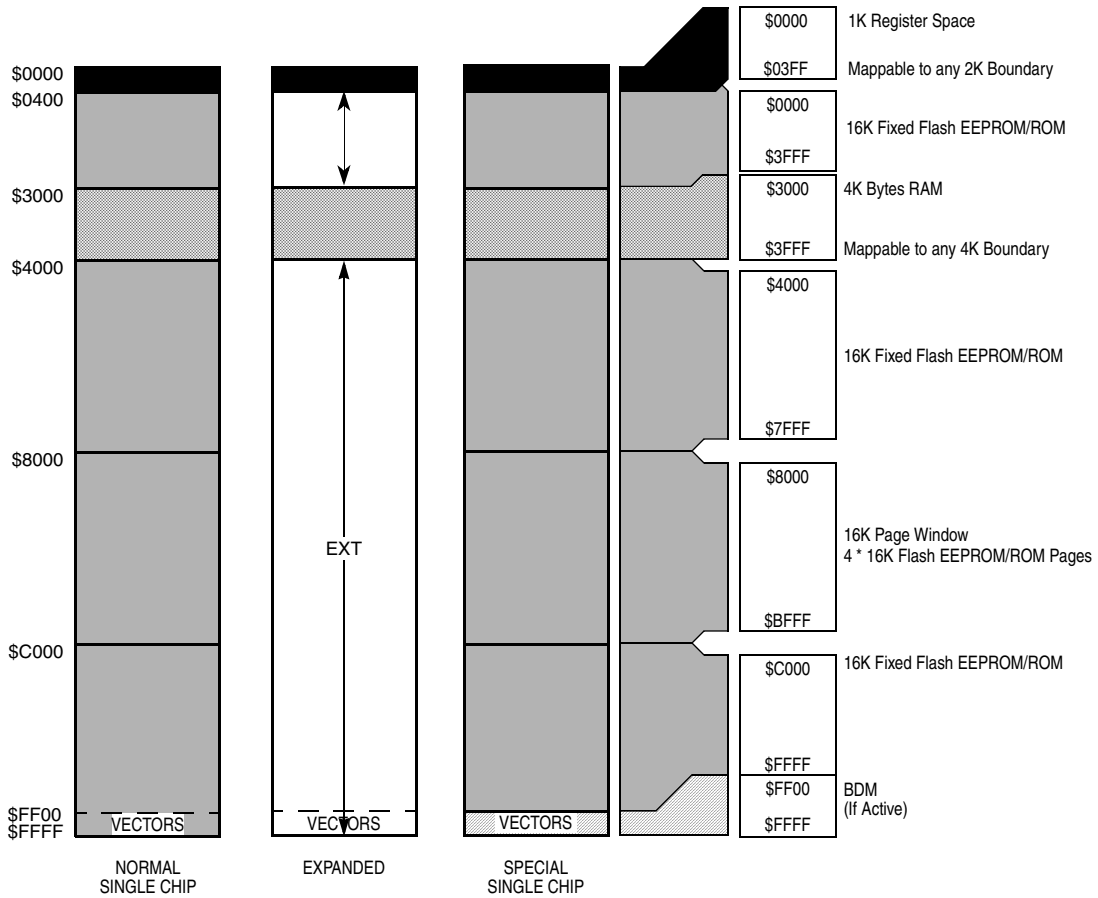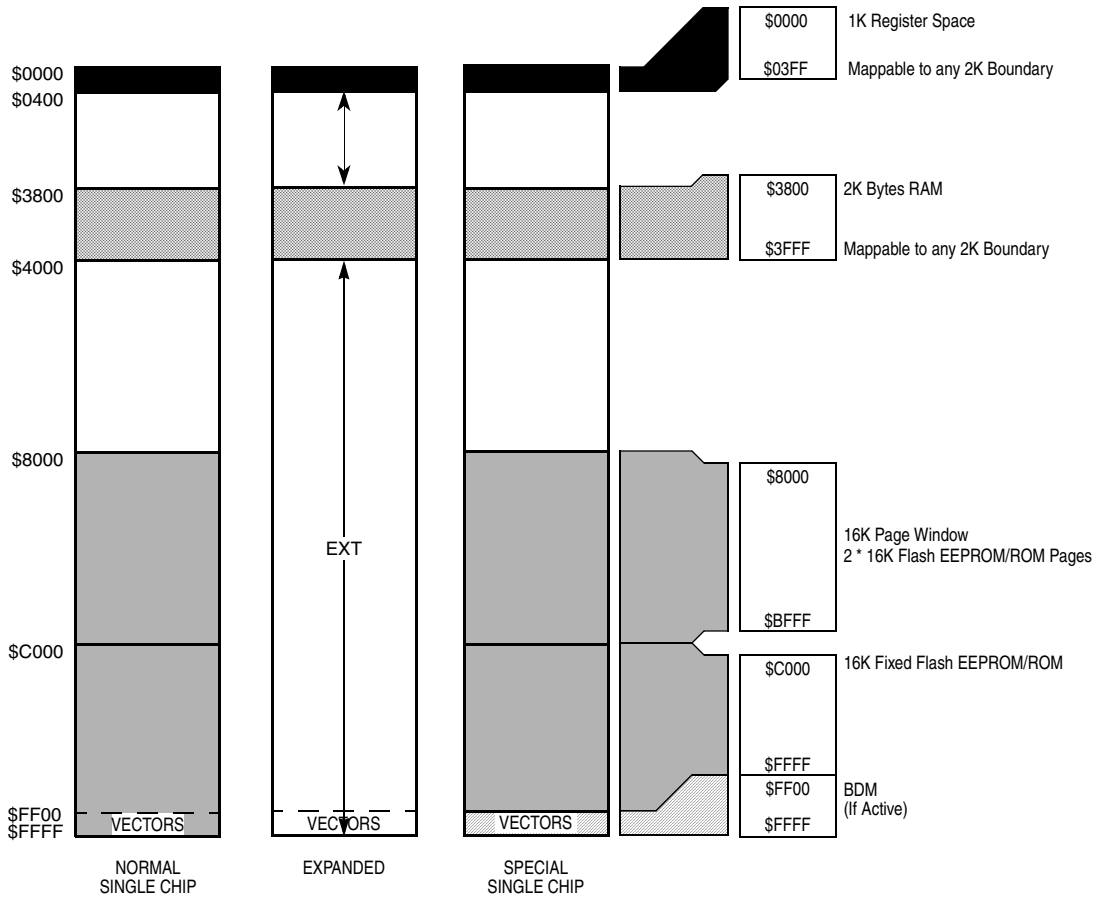
Figure 2 MCxS12C128 User Configurable Memory Map

				$0000	1K Register Space
				$03FF	Mappable to any 2K Boundary
$0000				$0000	16K Fixed Flash EEPROM/ROM
$0400				$3FFF	
				$3000	4K Bytes RAM
$3000					
				$3FFF	Mappable to any 4K Boundary
$4000				$4000	16K Fixed Flash EEPROM/ROM
		EXT			
$8000				$7FFF	
				$8000	16K Page Window
					6 * 16K Flash EEPROM/ROM Pages
				$BFFF	
$C000				$C000	16K Fixed Flash EEPROM/ROM
				$FFFF	
$FF00	VECTORS	VECTORS	VECTORS	VECTORS	$FF00	BDM (If Active)
$FFFF					$FFFF	

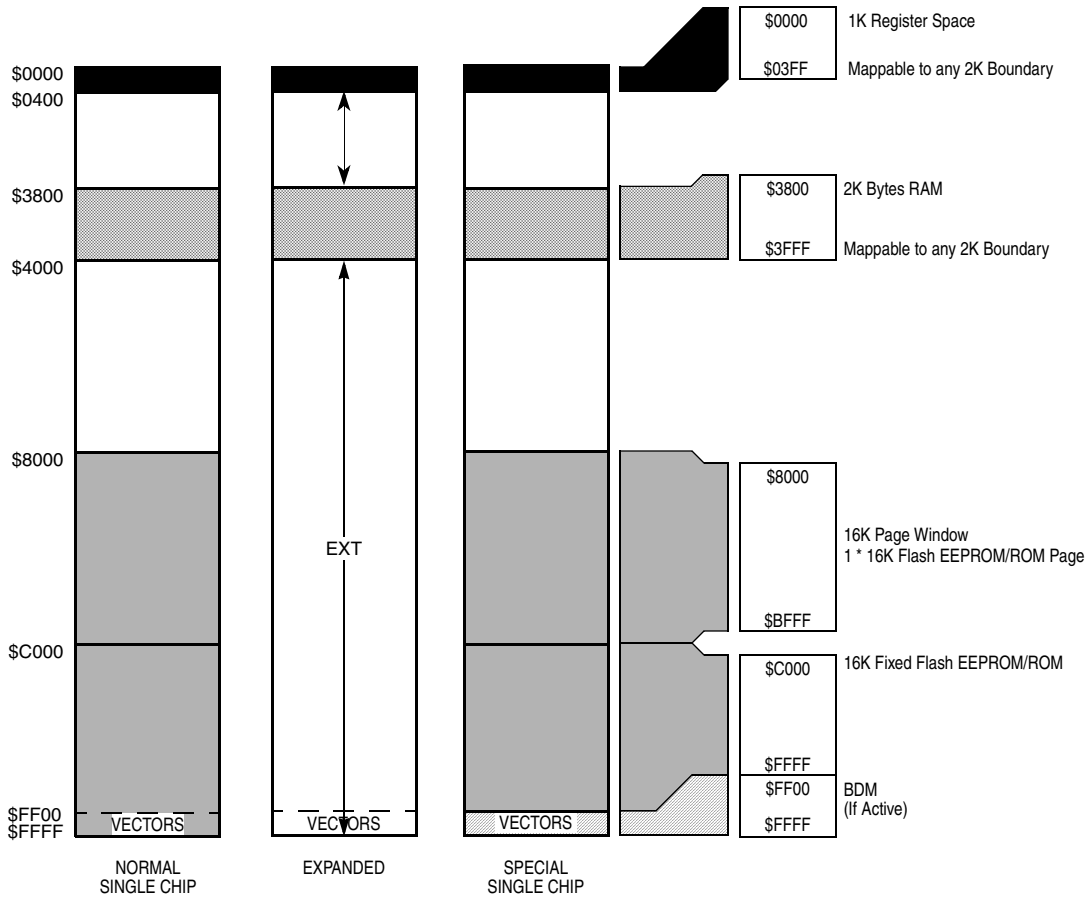| NORMAL SINGLE CHIP	EXPANDED	SPECIAL SINGLE CHIP	

The figure shows a useful map, which is not the map out of reset. After reset the map is:

$0000 - $03FF: Register Space
$0000 - $0FFF: 4K RAM (only 3K visible $0400 - $0FFF)

Flash Erase Sector Size is 1024 Bytes

Figure 3 MCxS12C96 User Configurable Memory Map

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				$0000	1K Register Space
				$03FF	Mappable to any 2K Boundary
				$0000	16K Fixed Flash EEPROM/ROM
				$3FFF	
				$3000	4K Bytes RAM
				$3FFF	Mappable to any 4K Boundary
				$4000	16K Fixed Flash EEPROM/ROM
				$7FFF	
				$8000	16K Page Window 4 * 16K Flash EEPROM/ROM Pages
				$BFFF	
				$C000	16K Fixed Flash EEPROM/ROM
				$FFFF	
				$FF00	BDM
				$FFFF	(If Active)

$0000
$0400
$3000
$4000

EXT

$8000

$C000

$FF00
$FFFF   VECTORS   VECTORS   VECTORS

NORMAL
SINGLE CHIP   EXPANDED   SPECIAL
SINGLE CHIP

The figure shows a useful map, which is not the map out of reset. After reset the map is:

$0000 - $03FF: Register Space
$0000 - $0FFF: 4K RAM (only 3K visible $0400 - $0FFF)

Flash Erase Sector Size is 512 Bytes

Figure 4 MCxS12C64 User Configurable Memory Map

The figure shows a useful map, which is not the map out of reset. After reset the map is:

$0000 - $03FF: Register Space
$0800 - $0FFF: 2K RAM

Flash Erase Sector Size is 512 Bytes

Figure 5 MCxS12C32 User Configurable Memory Map

The figure shows a useful map, which is not the map out of reset. After reset the map is:

$0000 - $03FF: Register Space
$0800 - $0FFF: 2K RAM

Flash Erase Sector Size is 512 Bytes

Figure 6 MCxS12C16 User Configurable Memory Map

Figure 7 Pin Assignments in 80 QFP for MC9S12C-Family
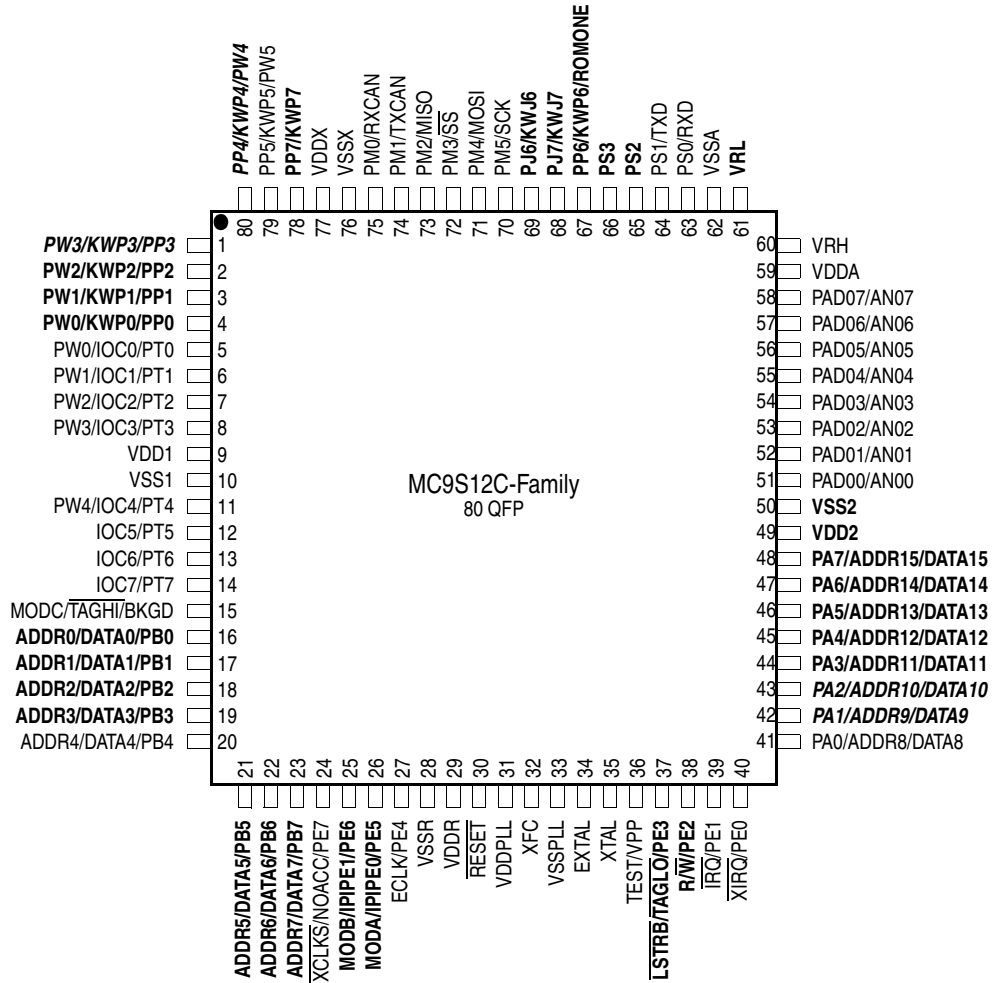
Signals shown in **Bold** are not available on the 52 or 48 Pin Package
Signals shown in *Bold Italic* are available in the 52, but not the 48 Pin Package

!!! Pin-out is Subject to Change!!!

Freescale Semiconductor, Inc.
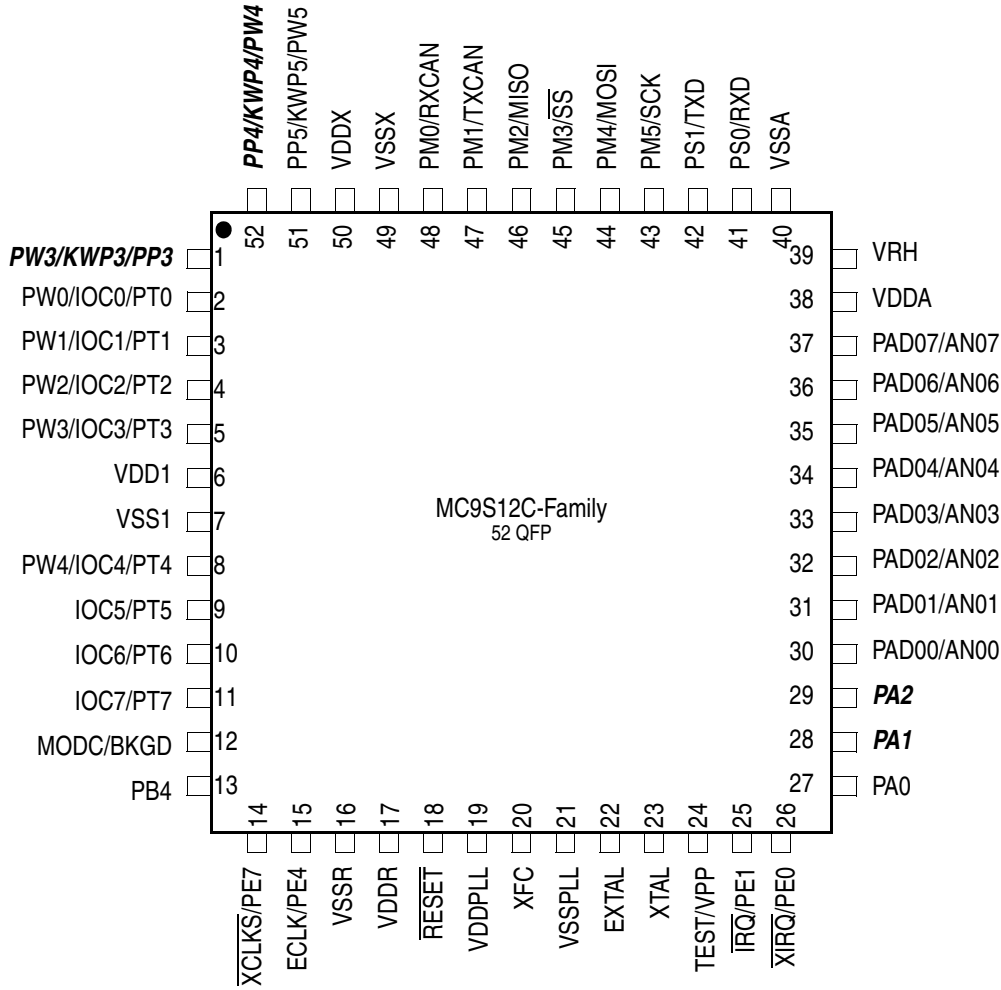
* Signals shown in **Bold** are not available on the 48 Pin Package

Figure 8 Pin assignments 52 QFP for MC9S12C-Family

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Pins (top row, left to right): PP5/KWP5 (48), VDDX (47), VSSX (46), PM0/RXCAN (45), PM1/TXCAN (44), PM2/MISO (43), PM3/$\overline{SS}$ (42), PM4/MOSI (41), PM5/SCK (40), PS1/TXD (39), PS0/RXD (38), VSSA (37)

Left side:
- 1 PW0/IOC0/PT0
- 2 PW1/IOC1/PT1
- 3 PW2/IOC2/PT2
- 4 PW3/IOC3/PT3
- 5 VDD1
- 6 VSS1
- 7 PW4/IOC4/PT4
- 8 IOC5/PT5
- 9 IOC6/PT6
- 10 IOC7/PT7
- 11 MODC/BKGD
- 12 PB4

Center: MC9S12C-Family 48 LQFP

Right side:
- 36 VRH
- 35 VDDA
- 34 PAD07/AN07
- 33 PAD06/AN06
- 32 PAD05/AN05
- 31 PAD04/AN04
- 30 PAD03/AN03
- 29 PAD02/AN02
- 28 PAD01/AN01
- 27 PAD00/AN00
- 26 PA0
- 25 $\overline{XIRQ}$/PE0

Bottom row (left to right): XCLKS/PE7 (13), ECLK/PE4 (14), VSSR (15), VDDR (16), $\overline{RESET}$ (17), VDDPLL (18), XFC (19), VSSPLL (20), EXTAL (21), XTAL (22), TEST/VPP (23), $\overline{IRQ}$/PE1 (24)

Figure 9 Pin Assignments in 48 LQFP for MC9S12C-Family

Package mechanical information
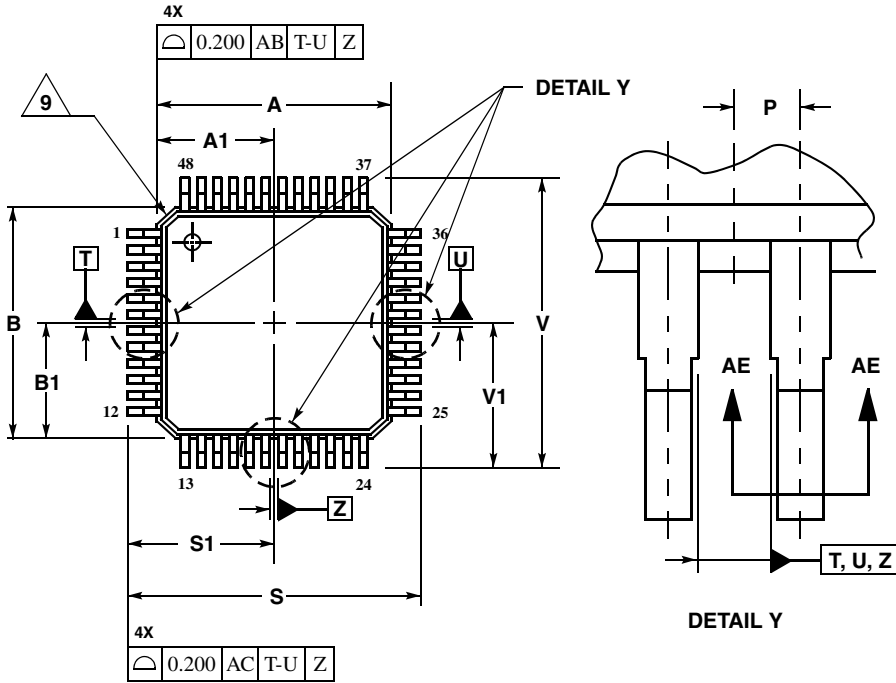
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
1. CONTROLLING DIMENSION: MILLIMETER.
2. DATUM PLANE AB IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
3. DATUMS T, U, AND Z TO BE DETERMINED AT DATUM PLANE AB.
4. DIMENSIONS S AND V TO BE DETERMINED AT SEATING PLANE AC.
5. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.250 PER SIDE. DIMENSIONS A AND B DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE AB.
6. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE D DIMENSION TO EXCEED

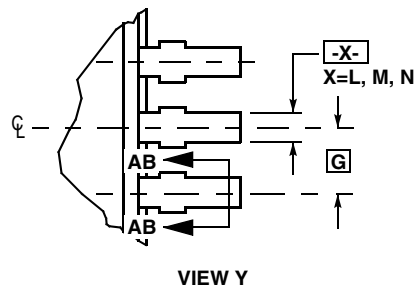| DIM	MILLIMETERS	
	MIN	MAX
A	7.000 BSC	
A1	3.500 BSC	
B	7.000 BSC	
B1	3.500 BSC	
C	1.400	1.600
D	0.170	0.270
E	1.350	1.450
F	0.170	0.230
G	0.500 BSC	
H	0.050	0.150
J	0.090	0.200
K	0.500	0.700
L	0 °	7 °
M	12 ° REF	
N	0.090	0.160
P	0.250 BSC	
R	0.150	0.250
S	9.000 BSC	
S1	4.500 BSC	
V	9.000 BSC	
V1	4.500 BSC	
W	0.200 REF	
AA	1.000 REF	

DETAIL Y

SECTION AE-AE

DETAIL AD
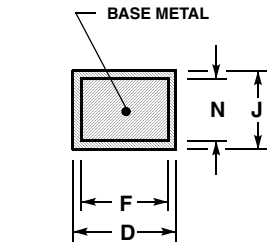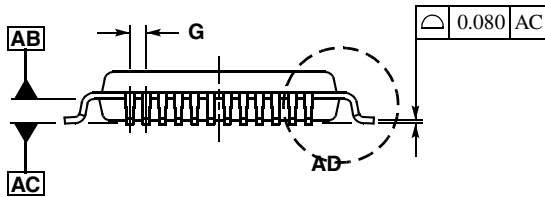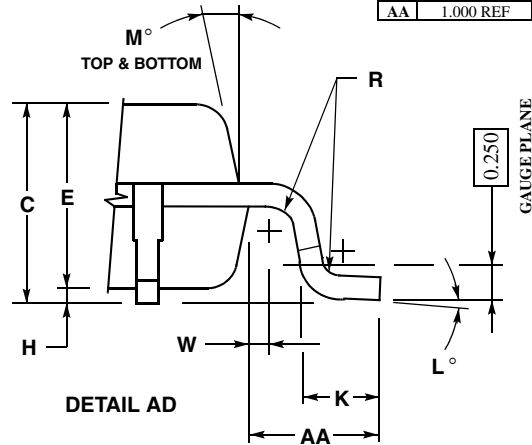
Figure 10 48-pin LQFP Mechanical Dimensions (case no.932-03 ISSUE F)

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4X

| △ | 0.20 (0.008) | H | L-M | N |

4X 13 TIPS

| △ | 0.20 (0.008) | T | L-M | N |

-X-
X=L, M, N

VIEW Y

PLATING — **BASE METAL**

| ⊕ | 0.13 (0.005) Ⓜ | T | L-M Ⓢ | N Ⓢ |
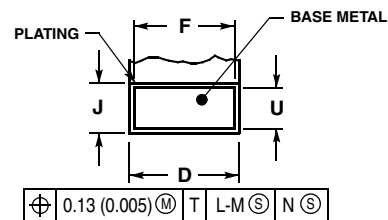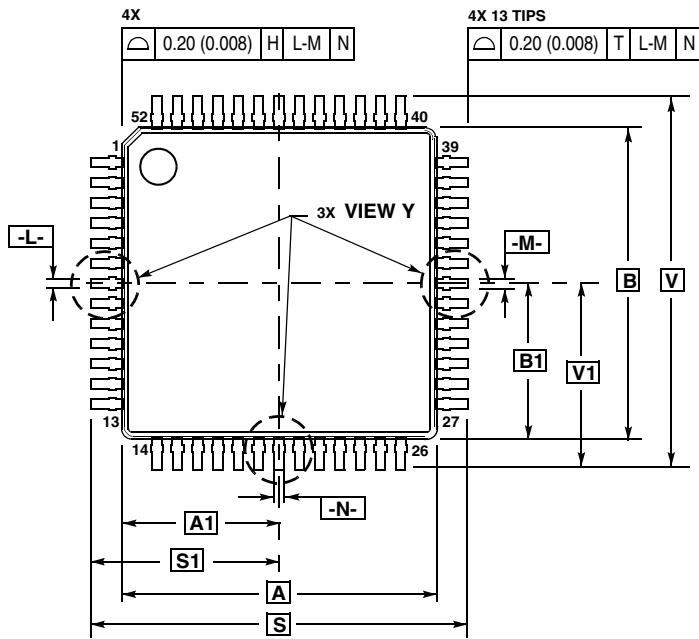
SECTION AB-AB

ROTATED 90° CLOCKWISE

NOTES:
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3. CONTROLLING DIMENSION: MILLIMETER
4. DATUM PLANE -H- IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
5. DATUMS -L-, -M- AND -N- TO BE DETERMINED AT DATUM PLANE -H-.
6. DIMENSIONS S AND V TO BE DETERMINED AT SEATING PLANE -T-.
7. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 (0.010) PER SIDE. DIMENSIONS A AND B DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-
8. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED 0.46 (0.018). MINIMUM SPACE BETWEEN PROTRUSION AND

3X VIEW Y

| △ | 0.10 (0.004) | T |

VIEW AA

| — | 0.05 (0.002) Ⓢ |

| 0.25 (0.010) |

GAGE PLANE

VIEW AA
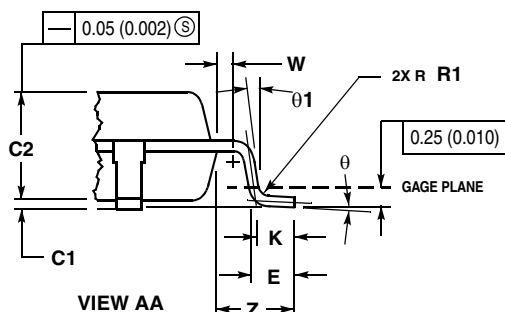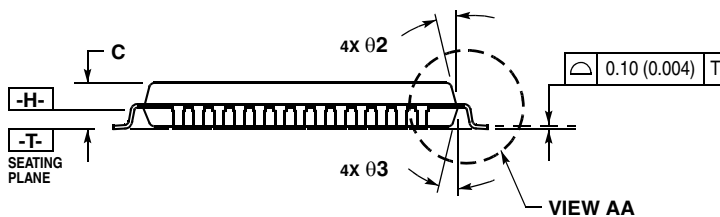
	MILLIMETERS		INCHES	
DIM	**MIN**	**MAX**	**MIN**	**MAX**
A	10.00 BSC		0.394 BSC	
A1	5.00 BSC		0.197 BSC	
B	10.00 BSC		0.394 BSC	
B1	5.00 BSC		0.197 BSC	
C	---	1.70	---	0.067
C1	0.05	0.20	0.002	0.008
C2	1.30	1.50	0.051	0.059
D	0.20	0.40	0.008	0.016
E	0.45	0.75	0.018	0.030
F	0.22	0.35	0.009	0.014
G	0.65 BSC		0.026 BSC	
J	0.07	0.20	0.003	0.008
K	0.50 REF		0.020 REF	
R1	0.08	0.20	0.003	0.008
S	12.00 BSC		0.472 BSC	
S1	6.00 BSC		0.236 BSC	
U	0.09	0.16	0.004	0.006
V	12.00 BSC		0.472 BSC	
V1	6.00 BSC		0.236 BSC	
W	0.20 REF		0.008 REF	
Z	1.00 REF		0.039 REF	
θ	0°	7°	0°	7°
θ1	0°	---	0°	---
θ2	12° REF		12° REF	
θ3	12° REF		12° REF	

Figure 11 52-pin LQFP Mechanical Dimensions (case no. 848D-03)

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NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DATUM PLANE -H- IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
4. DATUMS -A-, -B- AND -D- TO BE DETERMINED AT DATUM PLANE -H-.
5. DIMENSIONS S AND V TO BE DETERMINED AT SEATING PLANE -C-.
6. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 PER SIDE. DIMENSIONS A AND B DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
7. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT.

DIM	MILLIMETERS	
	MIN	MAX
A	13.90	14.10
B	13.90	14.10
C	2.15	2.45
D	0.22	0.38
E	2.00	2.40
F	0.22	0.33
G	0.65 BSC	
H	---	0.25
J	0.13	0.23
K	0.65	0.95
L	12.35 REF	
M	5°	10°
N	0.13	0.17
P	0.325 BSC	
Q	0°	7°
R	0.13	0.30
S	16.95	17.45
T	0.13	---
U	0°	---
V	16.95	17.45
W	0.35	0.45
X	1.6 REF	

Figure 12 80-pin QFP Mechanical Dimensions (case no. 841B)

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ASIA/PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Centre, 2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong. 852-266668334

CUSTOMER FOCUS CENTER: 1-800-521-6274

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