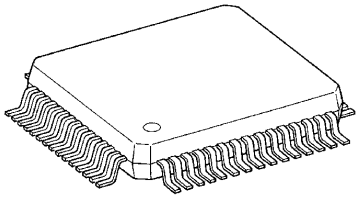
TENTATIVE TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC9444F

SINGLE-CHIP KARAOKE IC II

The TC9444F is a karaoke chip for such applications as equipment for CD / LD players, mini component stereo sets, radio-cassette players, and VCRs.
With its internal AD / DA converter system, the TC9444F can offer such karaoke functions as echo, vocal canceling, and key control on a single chip in addition to such digital signal processing (DSP) features as sound field control and bass / treble control.
Because the program and coefficients are stored on internal ROM, the IC can be controlled by simple settings.



QFP60-P-1414-0.80D

Weight : 1.08 g (Typ.)

FEATURES

- Incorporates an AD converter (three channels) with 2 times oversampling.

  THD : – 65 dB S / N ratio : 80 dB (typ.)

  built-in pre-filter op-amp

- Incorporates a 1-bit ΣΔ-type DA converter (two channels).

  THD : – 86 dB S / N ratio: 93 dB (typ.)

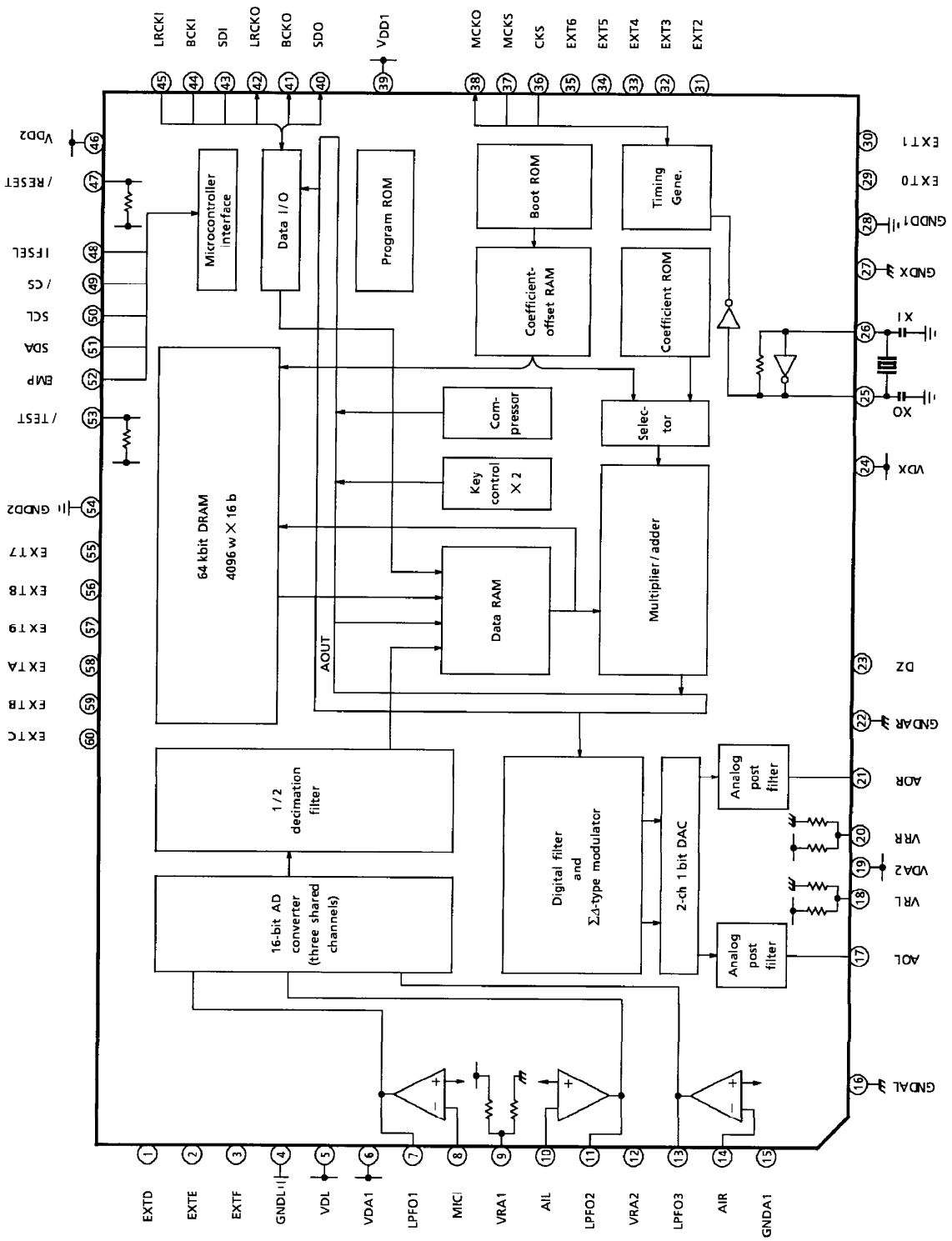
  built-in tertiary analog post filter

- Supports one port for digital input and one for digital output.
- Incorporates 64 Kbits of delay RAM
- Microcontroller interface : I^2C bus mode as well as Toshiba's original three-lead mode
- Built-in boot ROM initializes coefficients at reset or via a boot command.

COMPATIBLE SOFTWARE

- Microphone echo : Variable delay time / level
- Vocal cancellation : Attenuates only vocals from standard source
- Vocal change : Vocals fade in / out depending on whether there is input from microphone
- Vocal key control : For chorus and duet functions
- Supports multi-sound sources : Various modes
- Pseudo stereo : Monaural sources enhanced by sense of spaciousness
- Key control : 14-step (max ±1 octave) stereo key control
- Compressor or bass boost : Compression ratio selectable in range 6 to 36 dB. Compression effect (amount of boost) can be varied smoothly.
- Sound field control : Uses delay RAM to simulate such acoustic environments as churches, halls, sports stadiums, and discos.
- Equalizer : Characteristics switchable by coefficient or I / F bit settings
- 3D sound field : Offers 3-D sound.

BLOCK DIAGRAM/PIN ASSIGNMENT



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PIN DESCRIPTIONS

PIN No.	PIN NAME	I / O	FUNCTION	REMARKS
1	EXTO	O	Extended output port D	
2	EXTE	O	Extended output port E	
3	EXTF	O	Extended output port F	
4	GNDL	—	DRAM ground	
5	VDL	—	DRAM power supply	
6	VDA1	—	ADC power supply	
7	LPFO1	O	Op-amp output for microphone input	
8	MICI	I	Op-amp input for microphone input	
9	VRA1	—	ADC reference voltage 1	
10	AIL	I	Op-amp input for line L-channel	
11	LPFO2	O	Op-amp output for line L-channel	
12	VRA2	—	ADC reference voltage 2	
13	LPFO3	O	Op-amp output for line R-channel	
14	AIR	I	Op-amp input for line R-channel	
15	GNDA1	—	ADC ground	
16	GNDAL	—	DAC L-channel ground	
17	AOL	O	DAC L-channel output	
18	VRL	—	DAC reference voltage	
19	VDA2	—	DAC power supply	
20	VRR	—	DAC reference voltage	
21	AOR	O	DAC R-channel output	
22	GNDAR	—	DAC R-channel ground	
23	DZ	O	Digital zero input detection (“H” = zero detection)	
24	VDX	—	Oscillator block power supply	
25	XO	O	Oscillator connection	
26	XI	I	Oscillator connection or clock input	
27	GNDX	—	Oscillator block ground	
28	GNDD1	—	Digital ground 1	
29	EXT0	O	Extended output port 0	
30	EXT1	O	Extended output port 1	
31	EXT2	O	Extended output port 2	
32	EXT3	O	Extended output port 3	
33	EXT4	O	Extended output port 4	
34	EXT5	O	Extended output port 5	
35	EXT6	O	Extended output port 6	
36	CKS	I	System clock selection (“H” = 512 fs, “L” = 384 fs)	Schmitt input
37	MCKS	I	MCKO output clock selection (“H” = 1 / 1, “L” = 1 / 2 divider)	Schmitt input
38	MCKO	O	System clock output	
39	V_{DD1}	—	Digital power supply 1	
40	SDO	O	Digital audio data output	

PIN No.	PIN NAME	I / O	FUNCTION	REMARKS
41	BCKO	O	Bit clock output	
42	LRCKO	O	Channel clock output	
43	SDI	I	Digital audio data input	Schmitt input
44	BCKI	I	Bit clock input	Schmitt input
45	LRCKI	I	Channel clock input	Schmitt input
46	V_{DD2}	—	Digital power supply 2	
47	/ RESET	I (U)	Reset (“L” = reset)	With pull-up resistor Schmitt input
48	IFSEL	I	Microcontroller interface selection (“H” = three-lead mode, “L” = I^2C mode)	Schmitt input
49	/ CS	I	Three-lead mode : Command send start signal I^2C : chip select	Schmitt input
50	SCL	I	Microcontroller interface serial clock	Schmitt input
51	SDA	O	Microcontroller interface serial data	Schmitt input
52	EMP	—	De-emphasis setting (“H” = ON)	Schmitt input
53	/ TEST	I (U)	Test mode setting (“H” = fixed)	With pull-up resistor Schmitt input
54	GN_{DD2}	I	Digital ground 2	
55	EXT7	O	Extended output port 7	
56	EXT8	O	Extended output port 8	
57	EXT9	O	Extended output port 9	
58	EXTA	O	Extended output port A	
59	EXTB	O	Extended output port B	
60	EXTC	O	Extended output port C	

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	V_{DD}	−0.3~6.0	V
Input Voltage	V_{in}	−0.3~V_{DD} + 0.3	V
Power Dissipation	P_D	500	mW
Operating Temperature	T_{opr}	−40~85	°C
Storage Temperature	T_{stg}	−55~150	°C

ELECTRICAL CHARACTERISTICS (unless otherwise specified, Ta = 25°C、 V_{DD} = 5.0 V)
DC Characteristics

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITIONS	MIN	TYP.	MAX	UNIT
Operating Voltage		V_{DD}	—	Ta = −40~85°C	4.5	5.0	5.5	V
Current Consumption		I_{DD}	—	XI = 16.9 MHz, 384 fs mode	—	57	80	mA
Input Voltage	"H" level	V_{IH}	—	Digital input pins	V_{DD} × 0.8	—	—	V
	"L" level	V_{IL}			0	—	V_{DD} × 0.2	
Input Current	"H" level	I_{IH}	—	Digital input pins	—	—	1.0	μA
	"L" level	I_{IL}			−1.0	—	—	
Output Current 1 (*1)	"H" level	I_{OH1}	—	When V_{OH} = 4.5 V	−2.0	—	—	mA
	"L" level	I_{OL1}		When V_{OH} = 0.5 V	—	—	2.0	
Output Current 2 (*2)	"H" level	I_{OH2}	—	When V_{OH} = 4.5 V	−4.0	—	—	
	"L" level	I_{OL2}		When V_{OH} = 0.5 V	—	—	4.0	
Pull-up Resistors		R_{up}	—	/RESET, /TEST pin	—	50	—	kΩ

(*1) : DZ, XT0 to F, LRCKO, BCKO, SDO, DA pins
In I^2C bus mode, the SDA pin is "L" output only (open drain).
(*2) : MCKO pin

AC Characteristics
DA converter

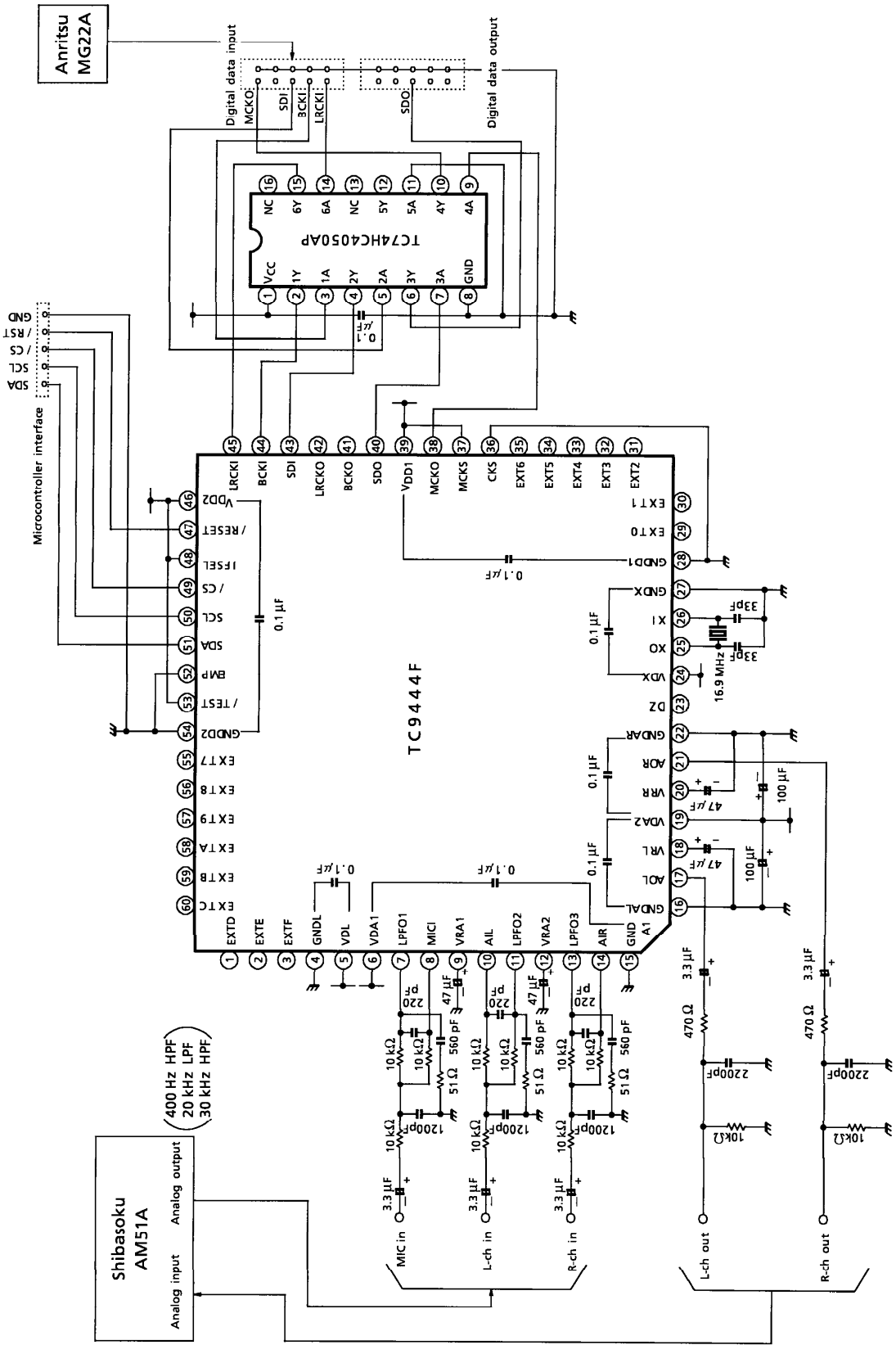
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITIONS	MIN	TYP.	MAX	UNIT
Maximum Input Level	Ain	1	V_{DD} = 5.0 V	—	1.15	1.20	V_{rms}
S / (N + D) Ratio	S / N (AD)	1	– 50 dB, 1 kHz sine wave input	72	80	—	dB
THD + N	THD (AD)	1	– 0 dB, 1 kHz sine wave input	—	– 65	– 57	
Crosstalk	CT (AD)	1	—	—	– 68	– 60	

DA converter

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITIONS	MIN	TYP.	MAX	UNIT
Output Level	Aout	1	—	—	1.2	—	V_{rms}
S / N Ratio	S / N (DA)	1	– 30 dB, 1 kHz sine wave input	84	93	—	dB
THD + N	THD (DA)	1	– 0 dB, 1 kHz sine wave input	—	– 86	– 78	
	THD (DA)	1	– 0 dB, 10 kHz sine wave input	—	– 83	– 75	
Crosstalk	CT (DA)	1	—	—	– 88	– 83	

Timings

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITIONS, REMARKS	MIN	TYP.	MAX	UNIT
Rise Time		t_r	—	CL = 50 pF, LRCKO, BCKO, SDO	—	—	30	ns
				MCKO	—	—	20	
Fall Time		t_r	—	CL = 50 pF, LRCKO, BCKO, SDO	—	—	30	ns
				MCKO	—	—	20	
Delay Time	Common	t_{d1}	—	XI→MCKO	—	—	20	ns
		t_{d2}		BCKO→SDO	—	—	5	
	In master mode	t_{d3}		XI→BCKO	—	—	15	ns
		t_{d4}		XI→LRCKO	—	—	30	
	In slave mode	t_{d5}		BCKI→BCKO	—	—	30	ns
		t_{d6}		LRCKI→LRCKO	—	—	30	
SDI Setup Time		t_{DIs}	—	—	50	—	—	ns
SDI Hold Time		t_{DIh}	—	—	50	—	—	ns
LRCKI Setup Time		t_{LRs}	—	—	50	—	—	ns
LRCKI Hold Time		t_{LRh}	—	—	50	—	—	ns
Interface Setup Time		T_1	—	—	0.2	—	—	μs
Interface Shift Clock Pulse Width		T_2, T_3	—	—	0.2	—	—	μs
Interface Data Setup Time		T_4	—	—	0.2	—	—	μs
Interface Data Hold Time		T_5	—	—	0.2	—	—	μs
Interface Hold Time		T_6	—	—	0.2	—	—	μs
Interface / CS Signal "H" Duration		T_7	—	—	0.2	—	—	μs
Coefficient and Offset RAM Write Cycle		T_8	—	—	1 / fs	—	—	s
Power-on Reset Time		T_{RST}	—	—	1	—	—	ms
Reset Pulse Width		T_{Rw}	—	—	0.2	—	—	μs
Boot Time		T_{BOOT}	—	Time required for boot	—	—	50	μs



TEST CIRCUIT 1

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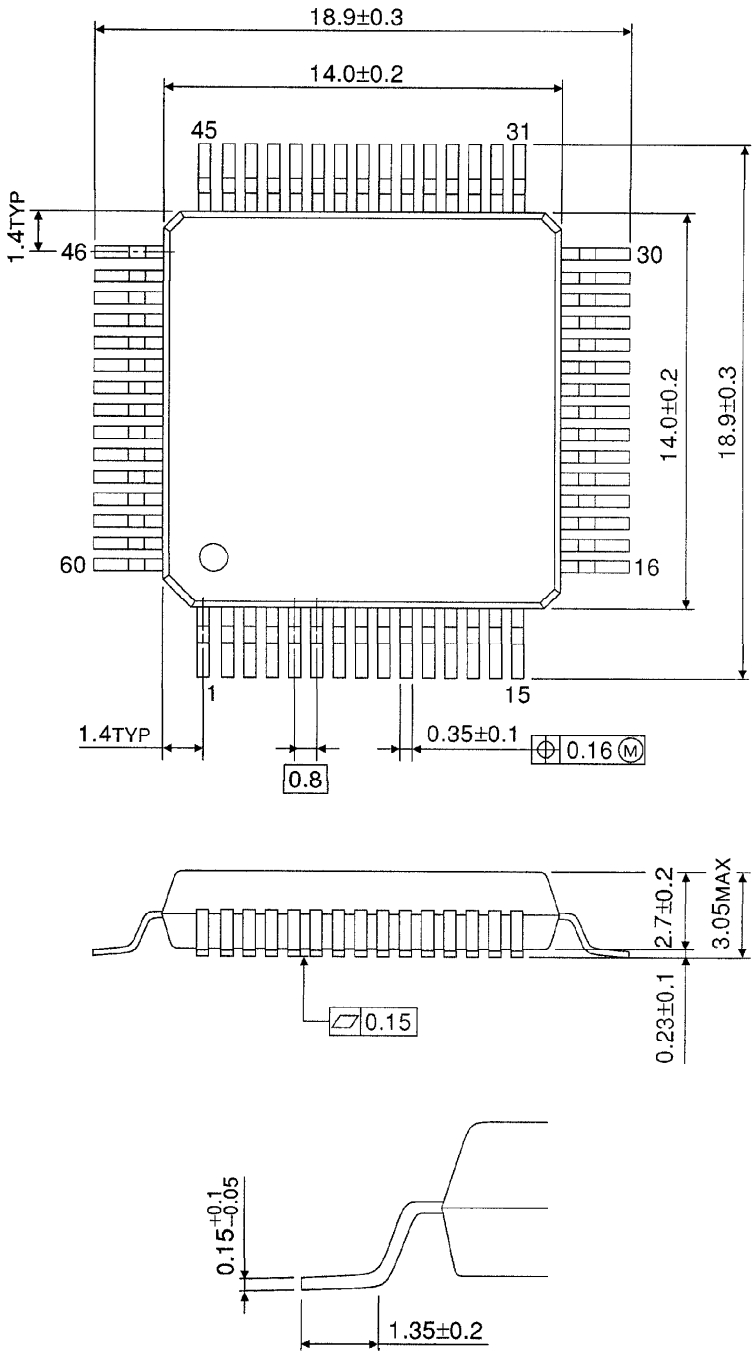
PACKAGE DIMENSIONS

QFP60-P-1414-0.80D

Unit : mm



Weight : 1.08 g (Typ.)