

VOICE SYNTHESIS LSI  
With External Rom  
MLC1036  
Specification

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Ver1.3

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Digital Speech Processing Lab.  
MCS Logic Inc.



## 1. General Description

The MLC1036 is a voice synthesis IC with external **MASK ROM, EPROM, or Flash Memory** for voice storage. This IC employs **MLPCM** voice coding algorithm and utilizes a low power CMOS technology for portable applications.

Since it has a built-in current mode 12-bit DA converter and digitally adjusted low pass filter, any kind of human voice or special sound output can be easily accomplished by using a few pieces of external components.

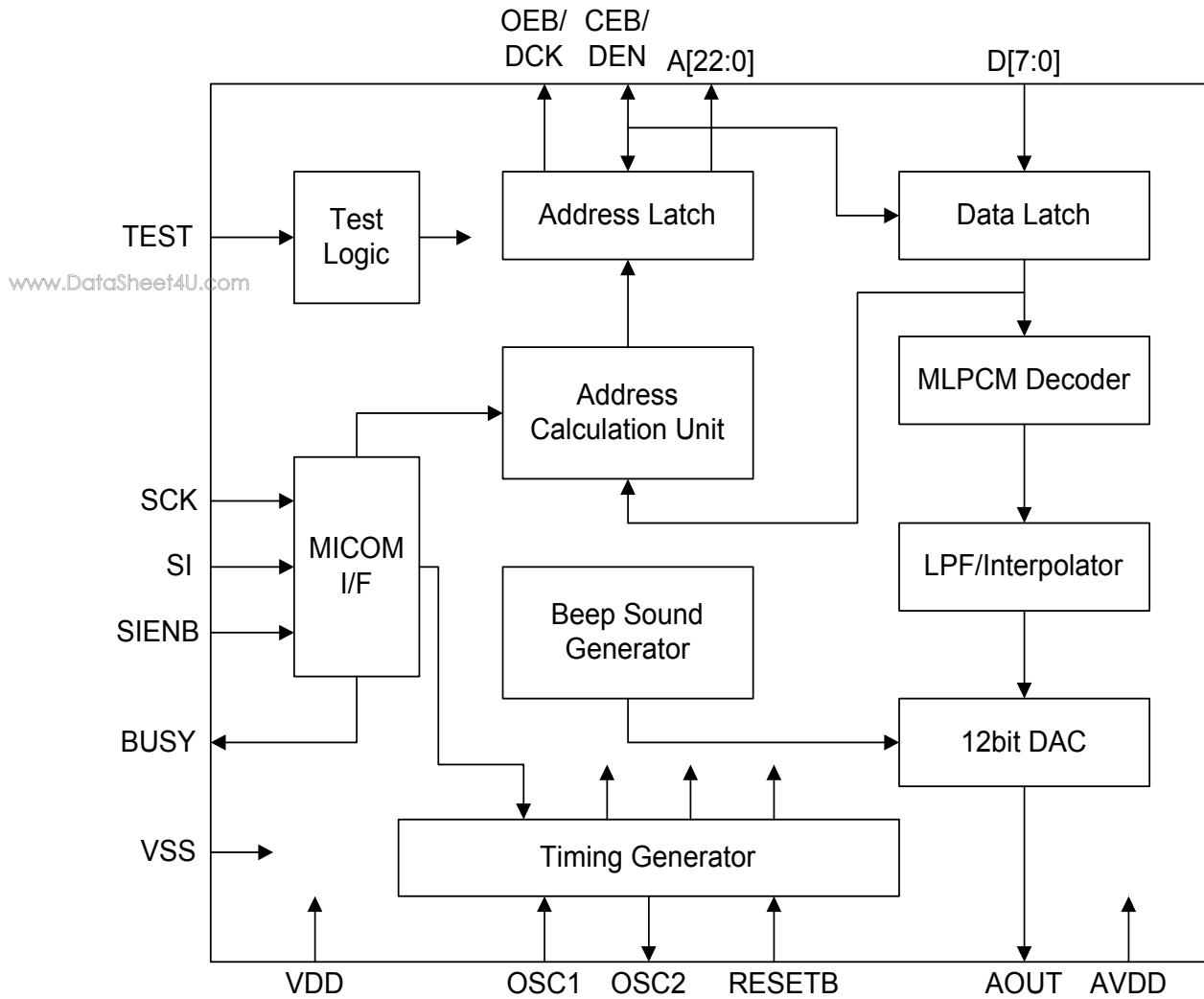
MLC1036 has simple MCU interface type control method. Therefore, users can easily control this IC.

@ **MLPCM** : Advanced voice coding method based on the modified ADPCM algorithm that is developed by MCS Logic.

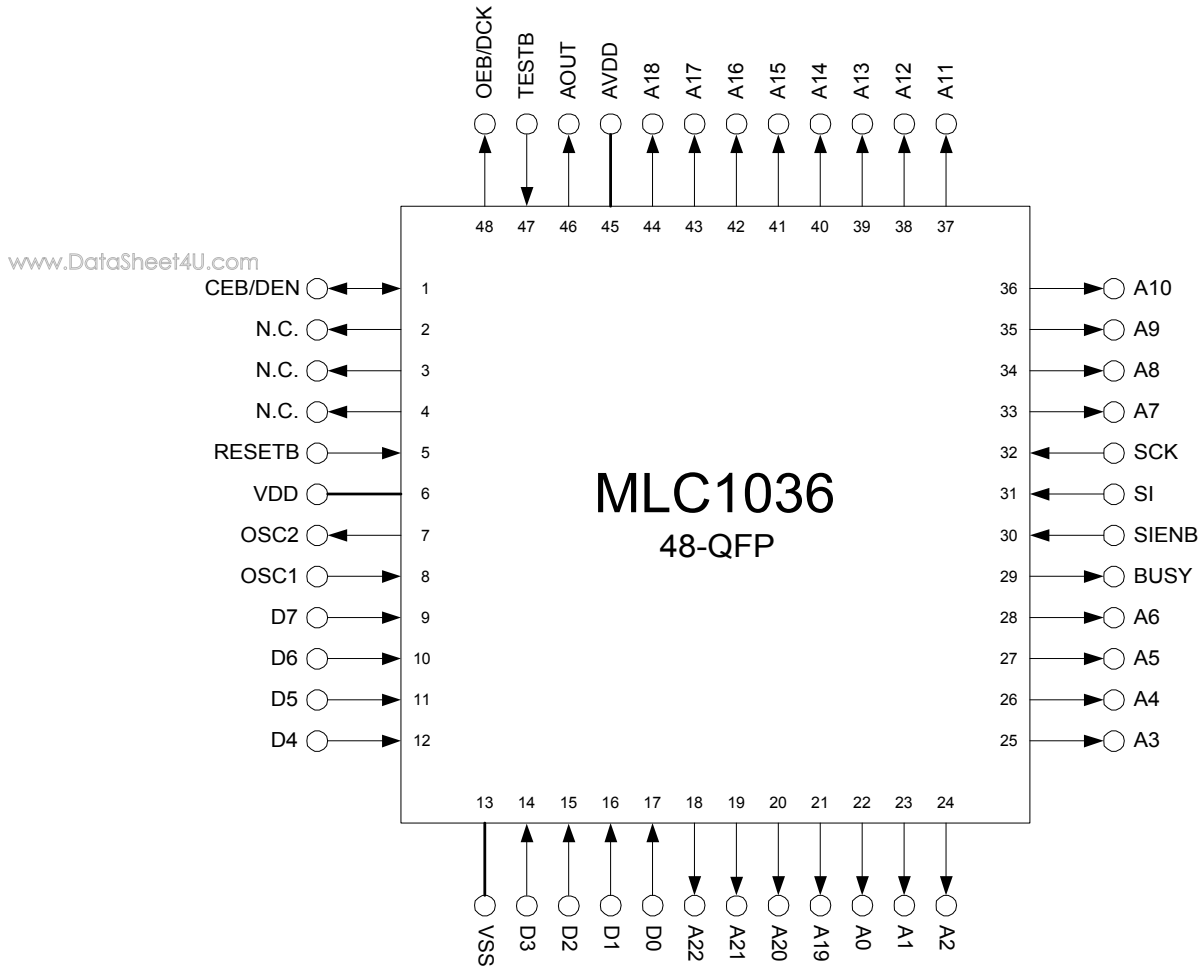
## 2. Features

- (1) Built-in Current mode 12bit DAC
- (2) Built-in digitally adjusted low pass filter & Interpolator
- (3) Variable Sampling Frequency(Fs)  
4KHz, 6.4KHz, 8KHz, 16KHz
- (4) Master Clock Frequency : 640KHz
- (5) Number of phrases : 256
- (6) External ROM : Mask ROM / EPROM / Flash Memory  
Maximum 8M \* 8bits
- (7) Variable Bit Rate  
16Kbps @ Fs = 4KHz, 25.6Kbps @ Fs = 6.4KHz  
32Kbps @ Fs = 8KHz, 64Kbps @ Fs = 16KHz
- (8) Beep Sound Generation  
2KHz, 256/512/1024msec
- (9) Repeat Function: 1 / 2 / 4 / 8 times
- (10) Two MCU Control method  
External ROM Read mode (Normal mode)  
Direct Data Pumping mode (DDP mode)
- (11) Package 48 QFP
- (12) 2.7 ~ 5.5V Supply voltage
- (13) Standby mode supported for low power consumption

### 3. Block Diagram



## 4. Package Diagram



## 5. PIN Description

No.	Pin Name	I/O Type	Description
1	CEB/DEN	I/O	External ROM Output Enable/Data Request Output. When DDP mode, this pin is Data Latch enable input pin.
2	N.C.	-	Must be not connected.
3	N.C.	-	Must be not connected.
4	N.C.	-	Must be not connected.
5	RESETB	I	System reset pin. Active low. <b>Pull-up</b>
6	VDD	Power	Digital VDD
7	OSC2	O	Oscillator Output
8	OSC1	I	Oscillator Input. 640KHz
9	D7	I	External ROM Input bit7
10	D6	I	External ROM Input bit6
11	D5	I	External ROM Input bit5
12	D4	I	External ROM Input bit4
13	VSS	Ground	Ground
14	D3	I	External ROM Input bit3
15	D2	I	External ROM Input bit2
16	D1	I	External ROM Input bit1
17	D0	I	External ROM Input bit0
18	A[22]	O	Address bit 22
19	A[21]	O	Address bit 21
20	A[20]	O	Address bit 20
21	A[19]	O	Address bit 19
22	A[0]	O	Address bit 0
23	A[1]	O	Address bit 1
24	A[2]	O	Address bit 2
25	A[3]	O	Address bit 3
26	A[4]	O	Address bit 4
27	A[5]	O	Address bit 5
28	A[6]	O	Address bit 6
29	BUSY	O	Chip Operating Status signal. "H": Operating state
30	SIENB	I	MCU Interface Serial Input Enable. <b>Pull-Up</b>
31	SI	I	MCU Interface Serial Input. <b>Pull-Up</b>
32	SCK	I	MCU Interface Serial Clock. <b>Pull-Up</b>
33	A[7]	O	Address bit 7
34	A[8]	O	Address bit 8
35	A[9]	O	Address bit 9
36	A[10]	O	Address bit 10
37	A[11]	O	Address bit 11
38	A[12]	O	Address bit 12
39	A[13]	O	Address bit 13
40	A[14]	O	Address bit 14
41	A[15]	O	Address bit 15
42	A[16]	O	Address bit 16
43	A[17]	O	Address bit 17
44	A[18]	O	Address bit 18

No	Pin Name	I/O Type	Description
45	AVDD	Power	Analog VDD
46	AOUT	O	Digital-to-Analog Converter Output pin. Analog Output signal
47	TESTB	-	Factory test Pin. <b>Must be connected to VDD</b>
48	OEB/DCK	O	External ROM Enable Output & Data Latch Clock Input When DDP mode, this pin is Data Request output pin.

## 6. Functional Description

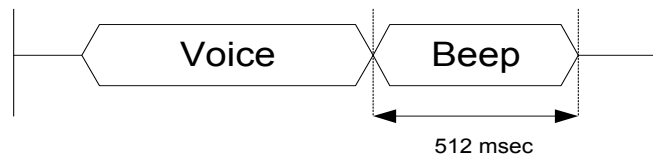
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### 6.1 Beep Sound Generation

This function is only used under MCU control mode. In this mode, MCU command bit 10 and bit 11 controls the beep sound function. If this function is selected, the beep sound can be generated after voice output. The beep sound frequency is 2KHz. The generation time can be 0msec(BEEP OFF), 256msec, 512msec, or 1024msec.

Bit 11	Bit 10	Frequency	Generation time(msec)
0	0	2KHz	0(OFF)
0	1	2KHz	256
1	0	2KHz	512
1	1	2KHz	1024

If the bit 11 is high and the bit 10 is low, the next timing diagram shows the relation between voice output and the beep sound.

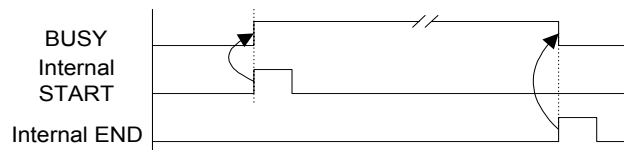




### 6.2 BUSY signal generation

If BUSY signal is activated (HIGH state), it means that the chip is in the operating mode. That is, this signal is activated while a MCU command is being executed or a voice is being played by any keys under “Stand-Alone” mode. Any command can not be applied to the IC while BUSY ON (BUSY = 1) but only MCU STOP command can be applied while BUSY ON (BUSY = 1).

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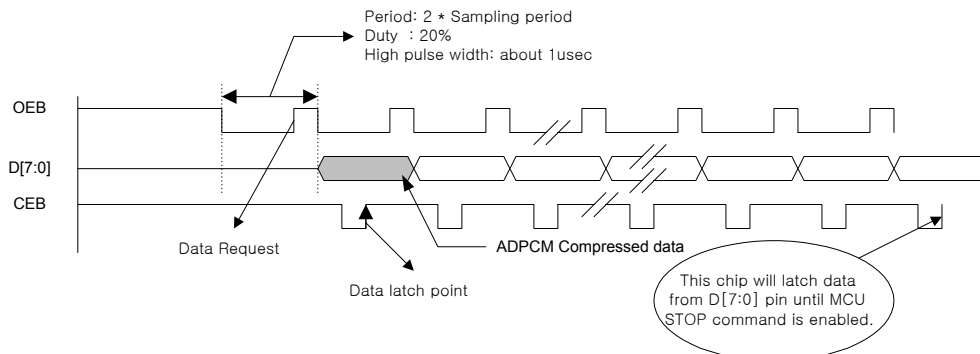


### 6.3 Phrase Selection

The MLC1036 has total 256 phrases. Users can select a phrase by using MCU command under normal mode. But users can not select a phrase under Direct Data Pumping mode (DDP mode). The MCU command has 8-bit for phrase number selection. It is from bit 0 to bit 7. The selected phrase number is calculated as follows:

$$\text{Phrase Number} = b7 * 2^7 + b6*2^6 + b5*2^5 + b4*2^4 + b3*2^3 + b2*2^2 + b1*2^1 + b0$$

Under DDP mode, MCU should send MLPCM compressed data (8bit data) to the MLC1036 chip. The chip does only decompress the compressed data. The next timing diagram shows data latch process under DDP mode.



## 6.4 Repeat Times Selection

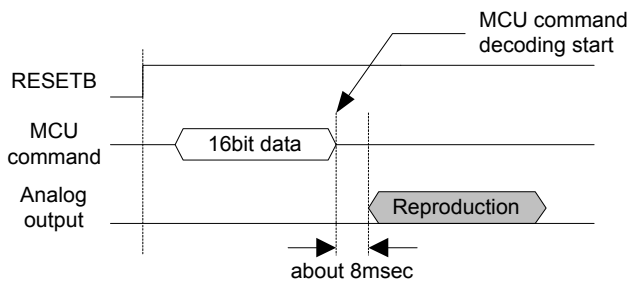
This chip has 4 kinds of repeat function under only normal mode of MCU control mode. Default mode is REP1 mode that is 1 times repetition mode.

Bit 9	Bit 8	Function
0	0	REP1 (1 times repetition mode)
0	1	REP2 (2 times repetition mode)
1	0	REP4 (4 times repetition mode)
1	1	REP8 (8 times repetition mode)

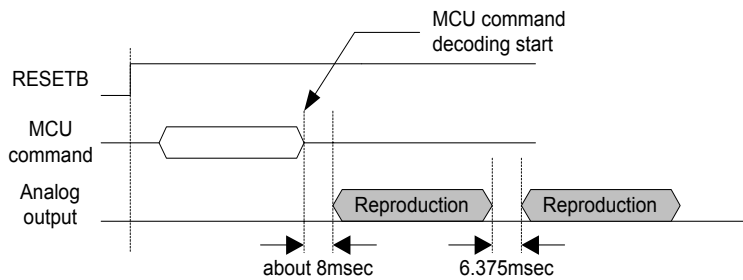
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### REP1 Mode Timing Diagram

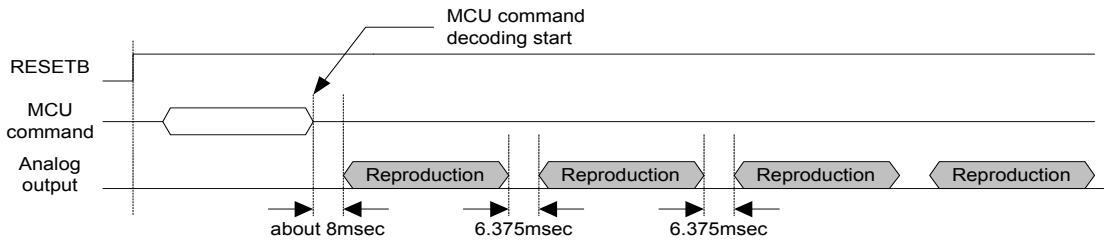
Internally, this chip will decode MCU command at the 16'th rising edge of the SCK.



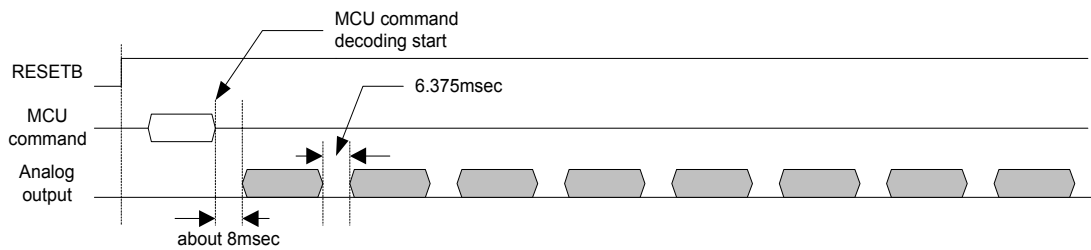
### REP2 Mode Timing Diagram



REP4 Mode Timing Diagram



www.DataSheet4U.com REP8 Mode Timing Diagram



### 6.5 Sampling Frequency Selection

User can select one of the several sampling frequencies. Each phrase that is stored in the internal Mask ROM can be 4KHz, 6.4KHz, 8KHz, or 16KHz sampling data. Bit 13 and bit 12 of MCU command control the sampling frequency selection. When user want to play some phrase, MCU command that has a sampling frequency and phrase number information should be sent to the chip.

Bit 13	Bit 12	Function
0	0	4KHz sampling frequency
0	1	6.4KHz sampling frequency
1	0	8KHz sampling frequency
1	1	16KHz sampling frequency

User can use this sampling frequency selection in **normal mode** and **DDP mode**.

## 6.6 Speech Volume Control

This function can be only used under DDP mode. This is a kind of digital volume control method. Final audio output level is decreased by 3 levels, which are -6dB, -12dB, and -18dB. If users do not want to use this volume control, user has to set the bit 6 and bit 5 to all zeros in MCU command.

Bit 6	Bit 5	Function
0	0	0dB Attenuation
0	1	-6dB(1/2) Attenuation
1	0	-12dB(1/4) Attenuation
1	1	-18dB(1/8) Attenuation

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## 6.7 Standby mode for Power-saving function

To reduce the power consumption, MLC103X has a standby mode for power saving function. Once the power is supplied and RESETB is activated, the chip is in the standby mode. In this mode, oscillation stop and power consumption is very small (A few uA). When the MCU command is inputted to MLC103X, this chip operates oscillator and voice synthesis is going on. After voice synthesis is end, the chip goes to the standby mode again.

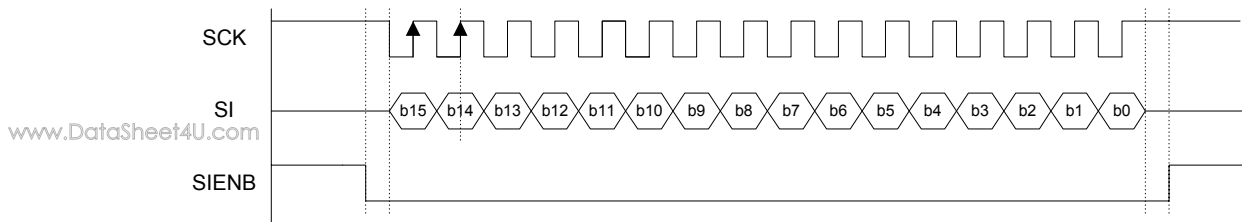
## 6.8 Stop function

Bit 14 of MCU command in MCU Control mode controls this function. This bit is the most high priority bit among 16 bits. If this bit is high, the current operation of MLC103X is stopped. Although BUSY is high, this STOP command is accepted by the MLC103X. But the other commands are not accepted.

## 7. MCU Command

### 7.1 MCU Interface Timing

The MLC103X has simple MCU interface method. Only 3 pins are connected to the MCU. The frequency of SCK is unlimited.



**The SI data order is MSB First.**

### 7.2 Normal mode : External ROM Read mode

Bit	Default Value	Function
15	0	Phrase Play Enable Bit (H: Enable, L: Disable)
14	0	Operation Stop Bit (H: STOP, L: Normal)
13	0	Sampling Frequency Selection Bit
12	0	(00: 4KHz, 01: 6.4KHz, 10: 8KHz, 11: 16KHz)
11	0	Beep Selection Bits
10	0	(00: OFF, 01: 256msec, 10: 512msec, 11: 1024msec)
9	0	Repeat Mode Selection Bits
8	0	(00: 1 time, 01: 2 times, 10: 4 times, 11: 8 times)
7	0	Phrase Number = $b7 * 2^7 + b6 * 2^6 + b5 * 2^5 + b4 * 2^4 + b3 * 2^3 + b2 * 2^2 + b1 * 2^1 + b0$ (phrase 0 ~ phrase 255)
6	0	
5	0	
4	0	
3	0	
2	0	
1	0	
0	0	

**In this mode, bit values of bit 15 and bit 14 have not to be all 1s.**

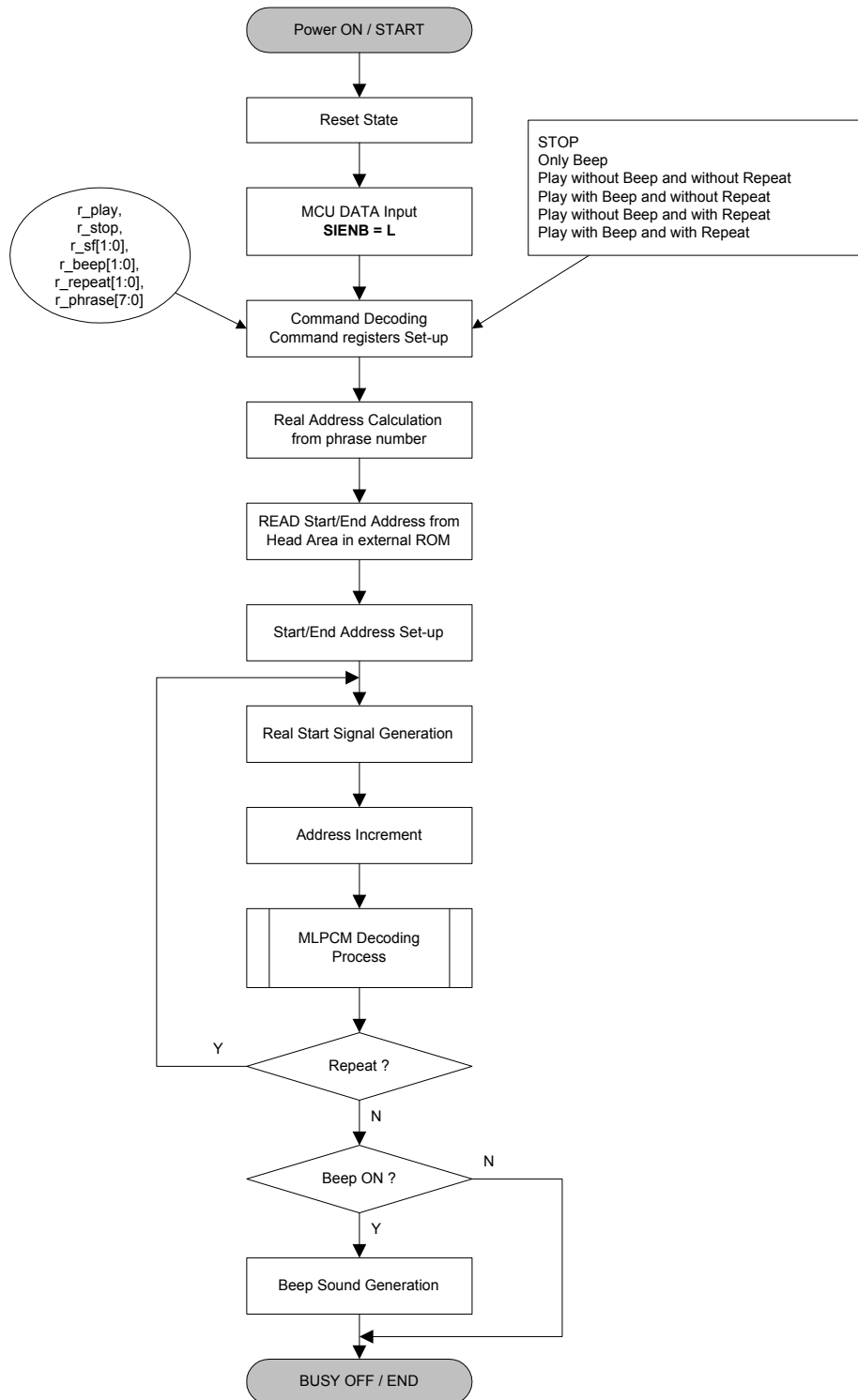
**Example)**

In case that Phrase Number = 42, Sampling frequency = 8KHz, Beep = 256 msec  
Repeat = 2 times

Speech Phrase start command: "1010010100101010"

Stop command: "01xxxxxxxxxxxxxx"

In this mode, MLC1036 is operated as follows:



### 7.3 DDP mode : Direct Data Pumping mode

MCU does directly pump the MLPCM compressed data to the chip.

Bit Function: {b15, b14} = 2'b11 => **DDP mode is selected.**

Bit	Default Value	Function
15	0	1
14	0	1
13	0	Sampling Frequency Selection Bit (00: 4KHz, 01: 6.4KHz, 10: 8KHz, 11: 16KHz)
12	0	
11	0	Don't Care Bits
10	0	
9	0	
8	0	
7	0	Operation Stop bit( H: STOP, L: Normal)
6	0	Speech Volume Control (00: 0dB, 01: -6dB, 10: -12dB, 11: -18dB)
5	0	
4	0	Don't Care Bits
3	0	
2	0	
1	0	
0	0	

Example)

In case: Sampling frequency = 8KHz, Speech Volume = -12dB

Phrase start command: "1110xxxx010xxxxx"

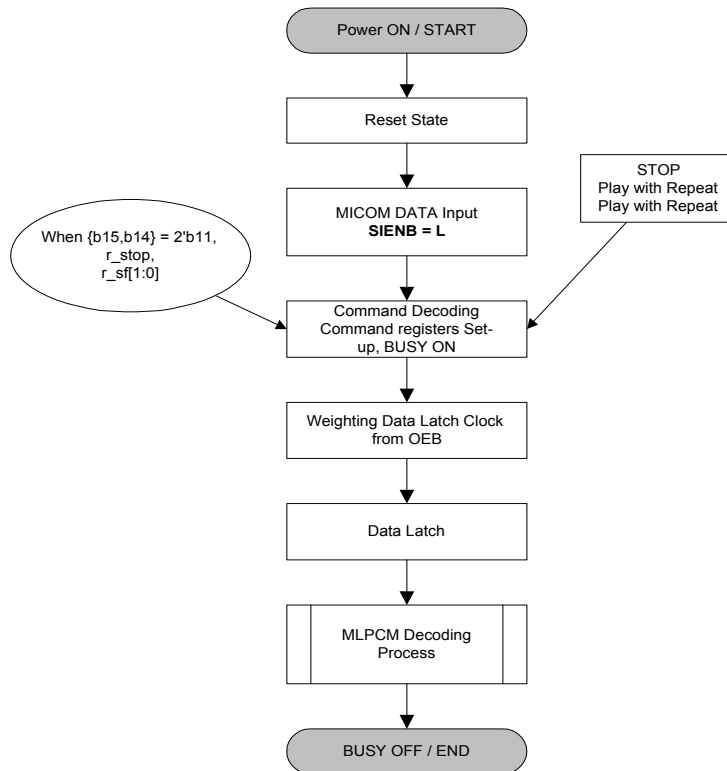
Phrase stop command: "11xxxxxx1xxxxxxx"

➔ MCU does not pump the compressed data to MLC1036 until phrase start command is inputted.

In this mode, MCU interface pins are as follows:

<i>SCK</i>	<i>Serial Clock input pin</i>
<i>SI</i>	<i>Serial Data input pin</i>
<i>SIENB</i>	<i>Serial Data Input Enable pin</i>
<i>D0 ~ D7</i>	<i>MLPCM Compressed Data input pin</i>
<i>CEB/DEN</i>	<i>MLPCM Compressed Data Latch Enable pin</i>
	$(F_{DCK} = \text{Sampling frequency} / 2)$
<i>OEB/DCK</i>	<i>MLPCM Compressed Data Request pin</i>

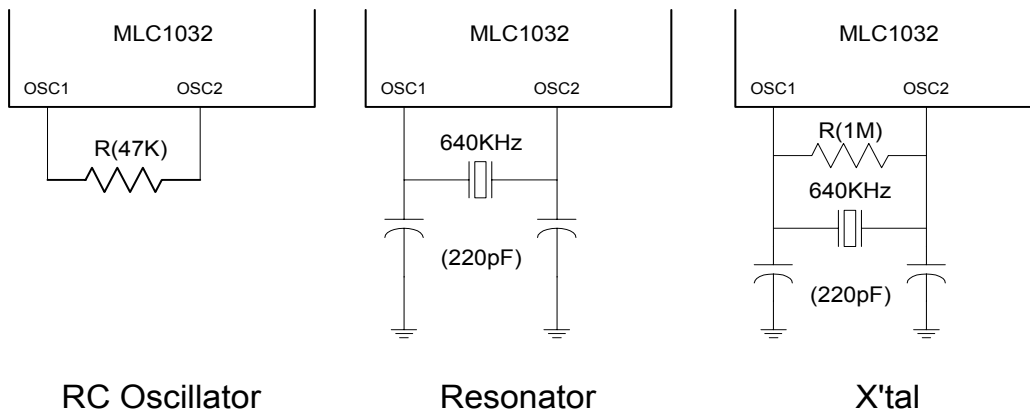
In this mode, MLC1036 operation flow is as follows:



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## 8. Oscillator

MLC103X is designed to use simple RC oscillator or Ceramic resonator or Crystal. The main oscillation frequency is 640KHz and following configuration is recommended.





## 9. Electrical Characteristics

### 9.1 Absolute Ratings

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	$V_{DD}$	$T_a = 25^\circ\text{C}$	-0.3 ~ 6.0	V
Input Voltage	$V_{IN}$	$T_a = 25^\circ\text{C}$	-0.3 ~ VDD+0.3	V
Operating Temperature	$T_a$	-	-20 ~ 85	$^\circ\text{C}$
Storage Temperature	$T_{STG}$	-	-55 ~ 150	$^\circ\text{C}$

### 9.2 Recommended Operating Conditions

Parameter	Symbol	Condition	Rating	Unit
Power Supply Voltage	$V_{DD}$	-	2.7 ~ 5.5	V
Master Clock Frequency	$f_{OSC}$	RC	640	KHz
Operating Temperature	$T_{OP}$	-	0 ~ 85	$^\circ\text{C}$

### 9.3 DC Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
High Input Voltage	$V_{IH}$	$2.7\text{V} < V_{DD} < 5.5\text{V}$	$0.8V_{DD}$	-	$V_{DD}$	V
Low Input Voltage	$V_{IL}$	$2.7\text{V} < V_{DD} < 5.5\text{V}$	$V_{SS}$	-	$0.2V_{DD}$	V
High Output Voltage	$V_{OH}$	$I_{OH} = -2\text{mA}$ $V_{DD} = 4.5\text{V}$	3.5	4.0	-	V
Low Output Voltage	$V_{OL}$	$I_{OL} = 2\text{mA}$ $V_{DD} = 4.5\text{V}$	-	0.2	0.5	V
Pull-Up Resistor (RESETB, SCK, SI, SIENB)	$R_{UP}$	$V_{DD} = 4.5\text{V}$	60	85	110	$\text{K}\Omega$
		$V_{DD} = 3\text{V}$	120	170	220	$\text{K}\Omega$
Stand-by Current	$I_{SB}$	$V_{DD} = 4.5\text{V}$	-	-	10	$\mu\text{A}$
		$V_{DD} = 3.0\text{V}$	-	-	3	$\mu\text{A}$
Operating Current (DAC not operated)	$I_{OP}$	DAC not selected $V_{DD} = 4.5\text{V}$ $@f_{OSC} = 640\text{KHz}$	-	-	2	mA
AOUT Current Output (DAC full scale)	$I_{CO}$	$V_{DD} = 4.5\text{V}$ , (AOUT=0V)	-5.0	-7.0	-9.0	mA

## 9.4 AC Characteristics

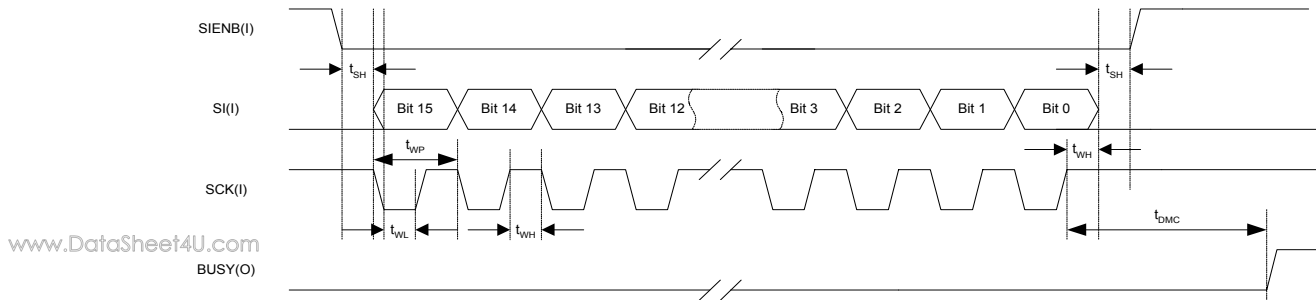
Unless specified,  $F_{OSC} = 640\text{KHz}$ ,  $V_{DD} = 5\text{V}$ 

Parameter	Symbol	Condition	Min	Typ	Max	Unit
SI hold time	$t_{SH}$	-	4	-	-	$\mu\text{sec}$
SCK pulse width	$t_{WP}$	-	10	-	-	$\mu\text{sec}$
SCK low level width	$t_{WL}$	-	4	-	-	$\mu\text{sec}$
SCK high level width	$t_{WH}$	-	4	-	-	$\mu\text{sec}$
BUSY enable delay time	$t_{DMC}$	-	-	6.4	-	msec
Data request low width	$t_{WLR}$	-		A		$\mu\text{sec}$
Data request high width	$t_{WHR}$	-		6.25		$\mu\text{sec}$
Data setup time	$t_{SUD}$	-	0.1	1	3	$\mu\text{sec}$
Valid data width	$t_{WAD}$	-	12.5	-	$2T_F$	$\mu\text{sec}$
Data latch clock delay	$t_{LCD}$	-	6.25	-	-	$\mu\text{sec}$
Data latch clock low width	$t_{WLC}$	-	6.25	-	-	$\mu\text{sec}$
Data latch clock high width	$t_{WHC}$	-	-	-	b	$\mu\text{sec}$
Processing group delay	$t_{GDP}$	-	-	116	-	$\mu\text{sec}$
Repeat delay time	$t_{RD}$	Final AOUT = $V_{DD}/2$	-	32	-	msec
DAC transition time	$t_{DAT}$		-	32	-	msec

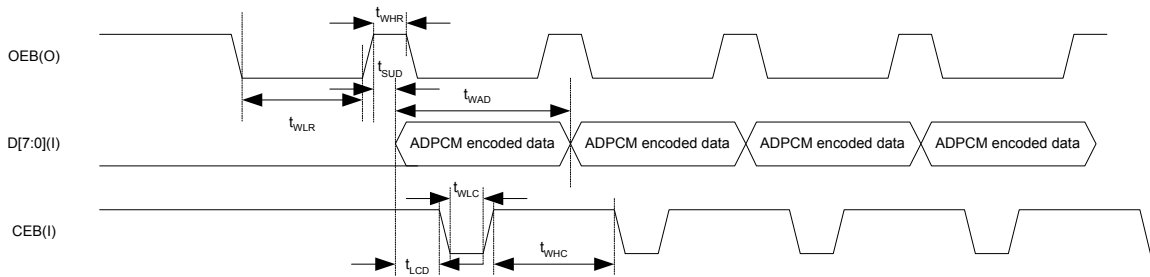
$T_F$  = Sampling period, a =  $2T_F - 6.25\mu\text{sec}$ , b =  $2T_F - 12.5\mu\text{sec}$

## 10. Timing Chart

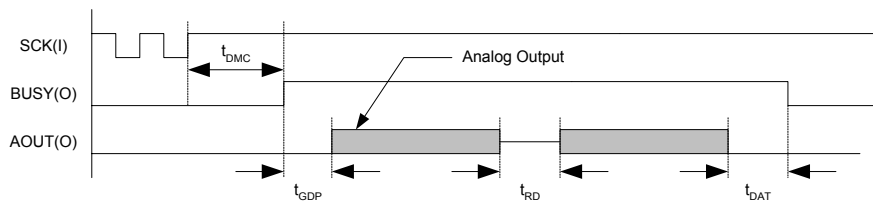
### 10.1 MCU Interface Time



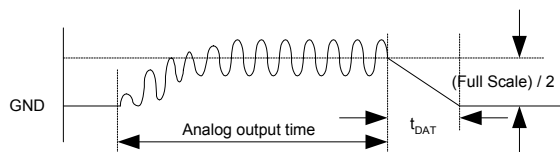
### 10.2 ADPCM Compressed Data Input Time for DDP mode



### 10.3 Analog Output Time in Repeat mode

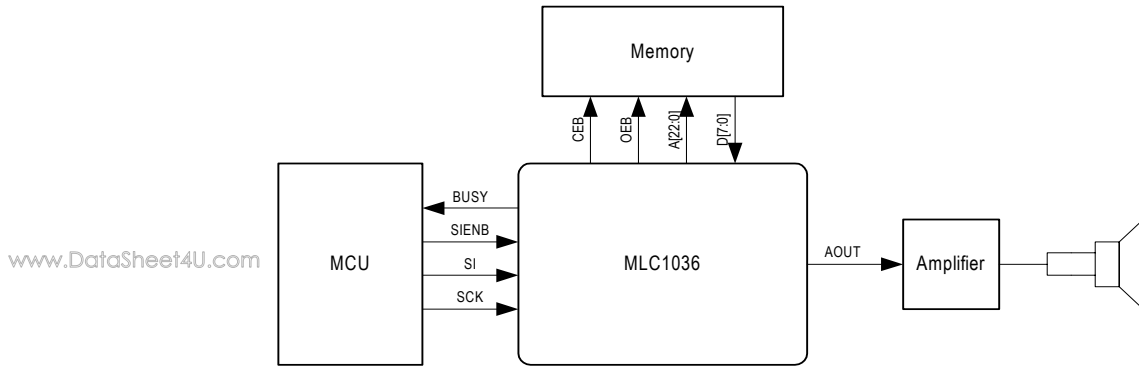


### 10.4 DAC Transition Time

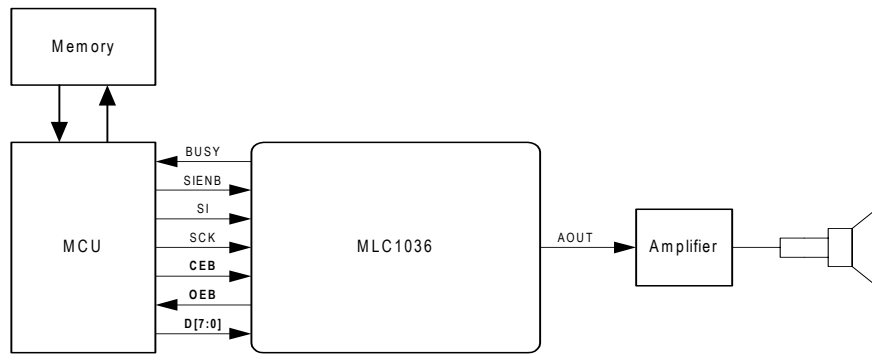


## 11. Application Circuit

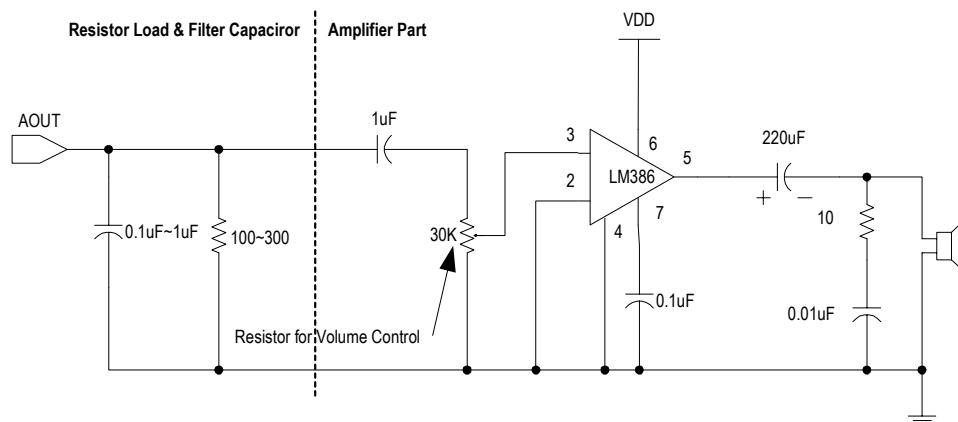
### 11.1 Normal Mode



### 11.2 DDP Mode



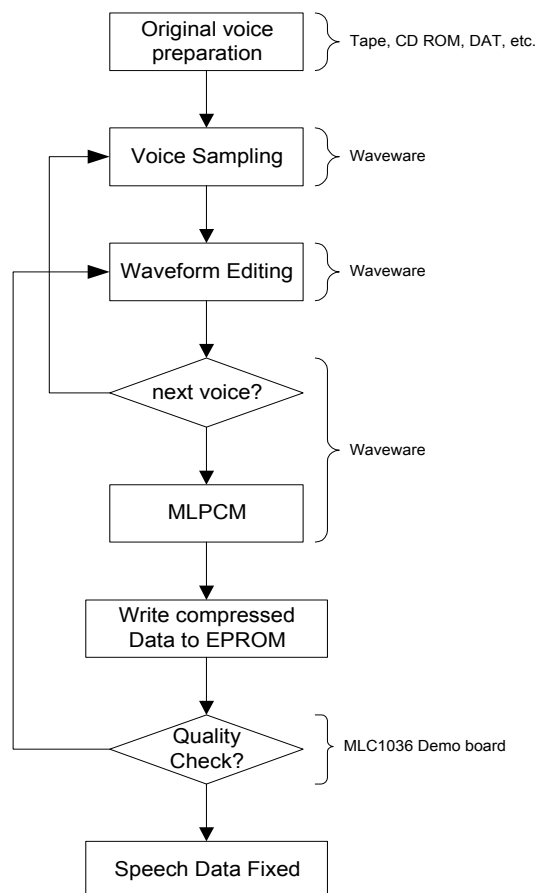
### 11.3 Example Amplifier Application(LM386)



## 12. Coding Software Tool

In order to use MLC1036, user prepares external ROM data to which the playback voice is compressed. At this time, user has to use our speech coding software "Waveware". If you want the coding software tool, please connect our home page <http://www.mcslogic.com>. Then you can download the software and users manual. The following flowchart shows the external ROM data generation method.

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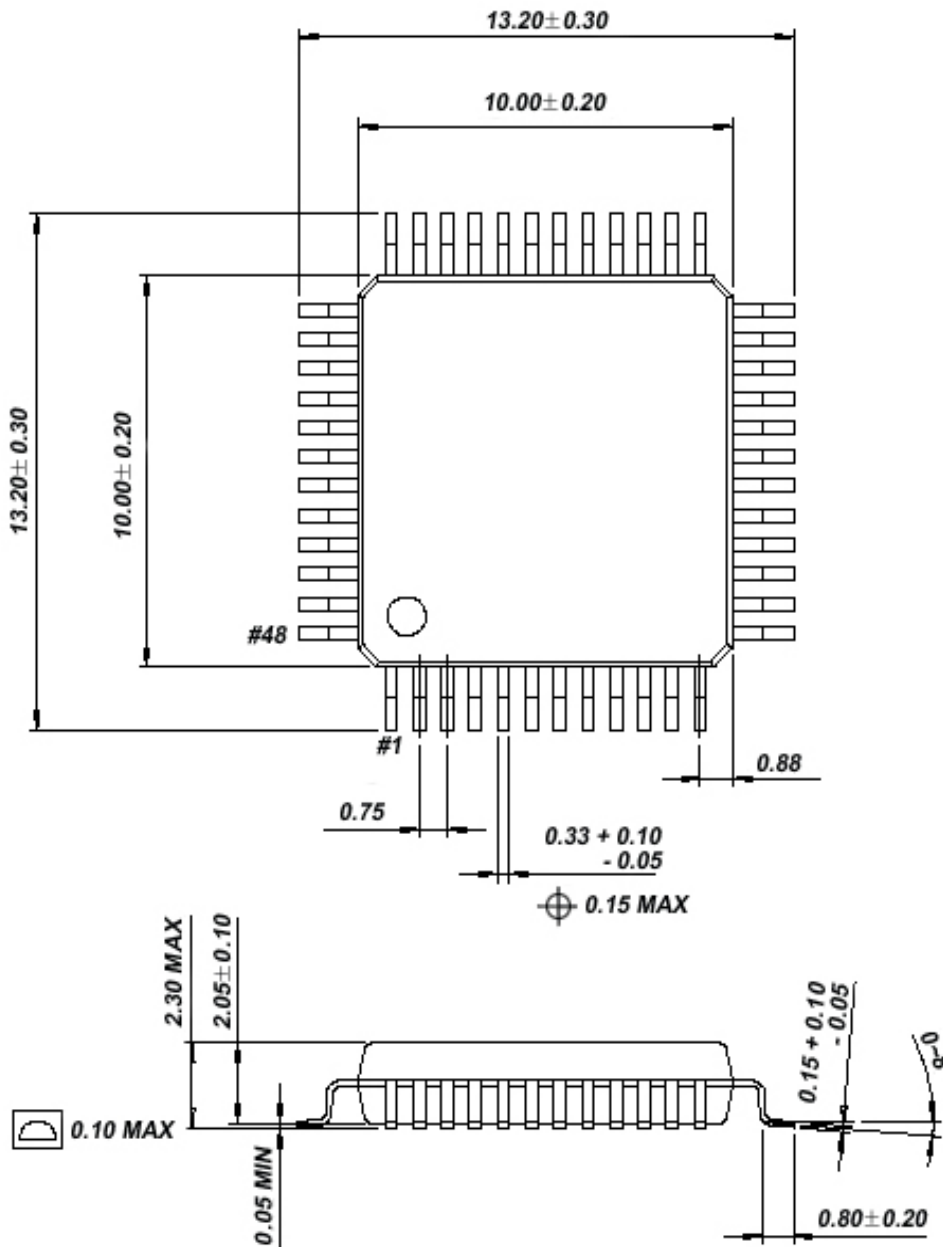


13. Dimensions

48 - QFP -1010E

Milimeters

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