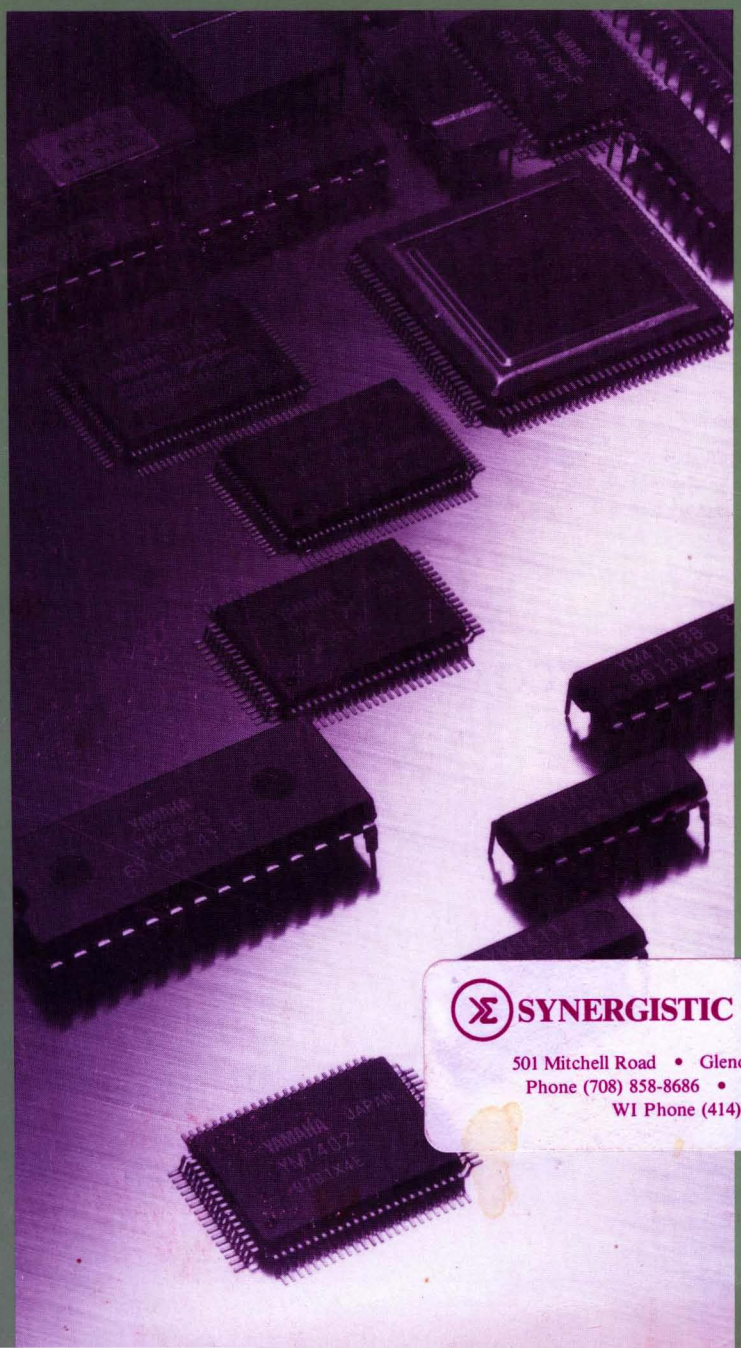
feelin' YAMAHA

YAMAHA LSI

CONDENSED CATALOGUE



SYNERGISTIC SALES, inc.
501 Mitchell Road • Glendale Heights, IL 60139
Phone (708) 858-8686 • FAX (708) 790-9799
WI Phone (414) 363-2020

INDEX

DIGITAL AUDIO

D/A CONVERTER

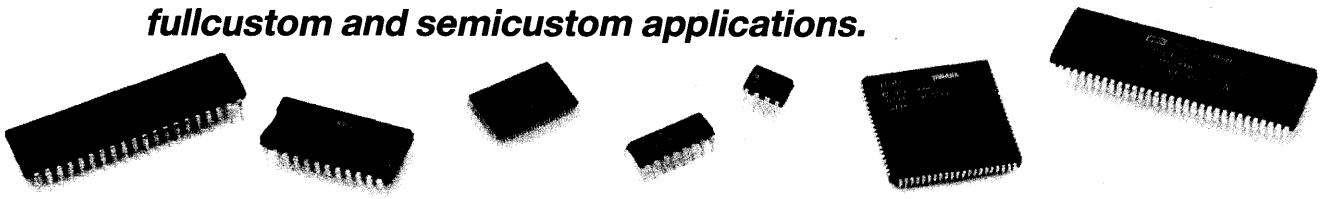
GRAPHICS

COMMUNICATION

SOUND SIGNAL PROCESSOR

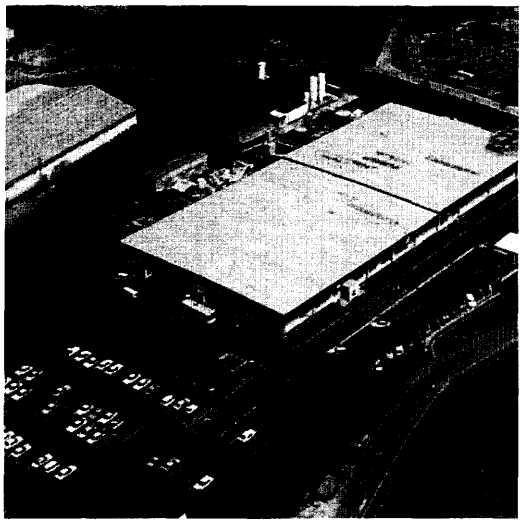
YAMAHA INTEGRATION

Seeking the best in sound reproduction, Yamaha has captured sound as digital information and created its own sound-oriented semiconductor technology.
By combining its experience in building electronic musical instruments with high-tech R & D work, Yamaha has mastered the art of making sophisticated LSI chips for graphics processing, communications, and fullcustom and semicustom applications.



Milestones in Yamaha® LSI Technology

The Yamaha plant at Toyooka, Japan, produces Electone digital keyboard instruments, wind instruments, and LSI circuits. This plant contains our primary LSI Research and Development Lab.



The Yamaha plant in Kagoshima, Japan – known as the Yamaha Kagoshima Semiconductor Company – produces LSI circuits.

1969	•IC manufacturing project initiated.
1970	•Construction of first IC manufacturing plant, at Toyooka, Japan, started. •IC production started.
1971	•Circuit-analyzing programs developed.
1972	•Mass production of MOS LSIs started. •Development of static induction transistors (SITs)–devices almost as fast as ECL but with the power consumption of CMOS–initiated. •Pulse analog system started.
1973	•Perfect-crystal technology established (i. e., growth of perfect silicon crystals on wafers). •Low-noise field-effect transistors developed. •Ion implanter added to production equipment. •"Yamaha-developed" computer-aided design (CAD) system put into operation.
1974	•SIT development work completed, mass production of 300-watt SITs initiated.
1975	•Rhythm-Auto-Base-Chord LSI developed.
1976	•Construction of second IC manufacturing plant, at Kagoshima, Japan, completed. •LSI circuits for electronic pianos developed. •Development of LSI FM sound generators initiated.
1977	•Electone digital keyboard instrument introduced. •Ultra-low-noise FET developed. •Complementary SIT developed. •LSI circuit for generating arpeggio effect developed.
1978	•Dry etcher added to production equipment. •Projection aligner–device that aligns the mask, via projection, to allow more dice per wafer to be obtained – added to production equipment.
1979	•SIT logic developed. •Device logic simulator developed.
1980	•VLSI circuit production initiated. •Automatic layout program developed. •Manufacturing process simulator developed.
1982	•SIT graphics vector generator LSI circuit developed, our first graphics chip. •MOS image sensor for use in home security.
1983	•Marketing of semiconductor products started–devices marketed include LSI circuits for advanced high-density discs, compact discs, FM musical sound generation, digital-to-analog conversion, and pressure sensors for printing press control. •Personal-computer based CAD system developed–includes tools for logic and mask-pattern design, can be interfaced to upper-level computers such as IBM mainframes. •Automatic LSI design system developed–performs mask-pattern generation; device layout, and standard-cell routing.
1984	•Marketing of custom LSI circuits initiated. •First personal computer based video processor LSI announced.
1987	•Production facility at Kagoshima incorporated as Yamaha Kagoshima Semiconductor Company. •Yamaha Corporation of America established Systems Technology Division to market components, boards and systems in The United States.

IBM, Hercules, and Microsoft are registered trademarks of IBM, Hercules Computer Technology and Microsoft Corporation.

DIGITAL AUDIO

Signal Processor & Controller (& RAM) for Compact Disc Player

YM7121B SPC5

■OUTLINE

YM7121B is one-chip CMOS LSI to provide various servo control and signal processing capabilities needed in compact disc players.

It has a built-in slice level control for EFM signals from optical pickup and a clock reproduction circuit; it performs EFM demodulation, error detection and correction, jitter absorption by internal RAM, and operation of various intelligent servo controls for focusing, disc motor, tracking, and feeding.

This LSI also has digital audio interface output capability conforming to EIAJ format and four-times oversampling digital filter adaptable to either 1DAC or 2DAC of MSB first output, to realize various applications.

The microprocessor command system containing conventional SPC with intensive automatic searching and track counting capabilities, and has upper compatibility at software level.

■FEATURES

- X'tal (16.9344 MHz) is connected to generate standard clock oscillation and necessary timing signals.
- The built-in VCO oscillation and slice level control circuit perform clock reproduction sync. signal separation, and EFM demodulation.
- In addition to sub code separation and output according to EIAJ format, Q sub codes are CRC checked for output to microprocessors.
- Phase difference between reproduced and standard clock signals is detected to control the disc motor with PWM.
- Command input on microprocessors administrates various servo controls for focusing search as well as tracking feed for quick access and skipping.
- In addition to automatic searching capability for quick access, track counter for high-speed searching is built in.
- The built-in RAM buffers the EFM demodulation signals to absorb wow and flutter of the disc.
  (Jitter absorption range ± 4 frames)
- EFM demodulation signals are unscrambled and de-interleaved.
- Error detection and correction as well as flag processing for digital audio signals (Double error correction method for both C1 and C2)

■ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Item	Symbol	Rating	Unit
Power supply voltage	VDD	−0.3~ +7.0	V
Input voltage	VI	−0.3~ VDD+0.5	V
Working temperature	Top	−20~ +75	℃
Storage temperature	Tstg	−50~ +125	℃

Recommended Operating Conditions (Condition: Ta = +25°C, VDD = 5.0 ± 0.25V)

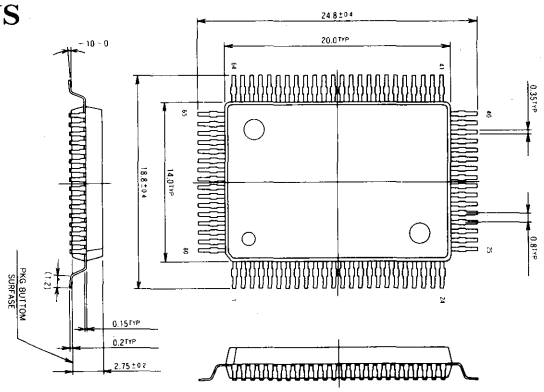
Item	Symbol	Minimum	Typical	Maximum	Unit
Power supply voltage	VDD	4.75	5.00	5.25	V
Clock frequency	XI		16.9		MHz
Working temperature	TOP	0	25	75	°C

Electrical Characteristics (Condition: Ta = +25°C, VDD = 5.0 ± 0.25V)

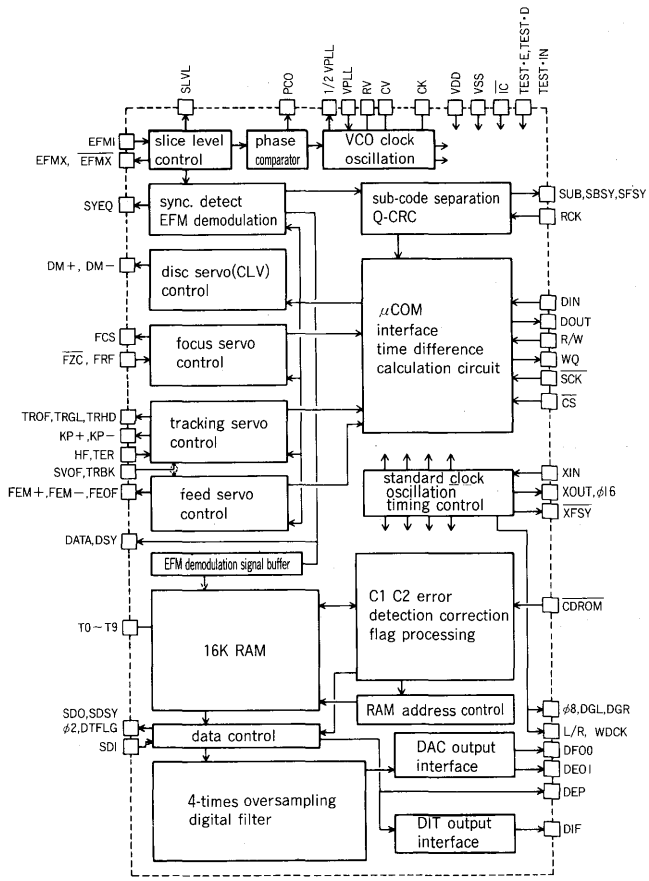
Item	Symbol	Condition	Minimum	Typical	Maximum	Unit	Remarks
Power supply voltage	IDD	VDD=5V				mA	
Output voltage H level	VOH	IDH=20μA	4.0			V	
Output voltage L level	VOL	IOL=1mA			0.4	V	
Input voltage H level (1)	VIE 1		3.5			V	Note 1
Input voltage L level (1)	VIL 1				1.5	V	Note 1
Input voltage H level (2)	VIE 2		2.0			V	Note 2
Input voltage L level (2)	VIL 2				0.5	V	Note 2

Note 1: Applicable to EFMI, FZC, FRF, EF and TER Terminal. Note 2: Applicable to RCK, DIN, SCK.

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



DIGITAL AUDIO

CD/CDV Digital Audio Processor

YM7402 CDVP

■OUTLINE

YM7402 is a one-chip LSI containing various circuits for digital audio signal processing used in optical multi disc compatible players as well as servo control and signal precessing capabilities needed in CD players.

In addition, sequential control of tracking/feed for high speed searching, digital audio interface output, digital volume adjustment, and peak holding functions are included for use in high-grade CD players and compatible players.

■FEATURES

- X'tal (16.9344 MHz) is connected to generate standard clock oscillation and timing signals.
- EFM-PLL circuit with built-in VCO reproduces bit clock pulses.
- Built-in slice level controller
- Two switchable modes (CD/LD) are available for EFM input.
- Linear interpolation is used to replace the uncorrectable error data (up to a maximum if 8 consecutive errors). And preceding data hold is applied for errors over eight.
- The data output is in MSB first format and four-times oversampling digital filter with stop band attenuation of 40 dB or more is built in.
- EFM data demodulation and intensive error correction capabilities (double error correction for both C1 and C2).
- Buffering of EFM demodulation signals by 16K built-in RAM (Jitter absorption range ± 4 frames)
- Sub code separation and output conforming to EIAJ.
- Digital audio interface output conforming to EIAJ with arbitrary setting of channel status code.
- MSB first audio data output with switchable audio output method adaptable for bilingual laser disc.
- Facusing servo control compatible with external equipment.
- Tracking & feed servo controls by direct and automatic sequence controls for high-speed searching and linear motor.
- Built-in tracking counter allowing adjustment with a unit of one track.
- PWM spindle servo control containing FG mode realized by frequency generator connection.
- VCXO control for compatible players.
- High performance microprocessor serial interface enabling precise control.
- Digital attenuator for 0.4 dB and 240 steps is built in.
- Zero cross mute functions to suppress mute noises.
- Peak holding capability to output maximum audio level for peak level searching and level meter.
- Error flag output without interpolation for CD-ROM.
- 80-pin flat packaged silicone gate CMOS LSI, operated by + 5V power supply.

■ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Item	Symbol	Rating	Unit
Power supply voltage	VDD	−0.3～+7.0	v
Input voltage	VI	−0.3～VDD+0.5	v
Working temperature	Top	−20～+75	t
Storage temperature	Tasg	−50～+125	t

(Condition: Ta = + 25℃, VDD=5. 0±0. 25V)

Recommended Operating Conditions

Item	Symbol	Minimum	Typical	Maximum	Unit
Power supply voltage	VDD	4.75	5.00	5.25	V
Clock frequency	XI		16.03		XHz
Working temperature	TOP	0	25	75	℃

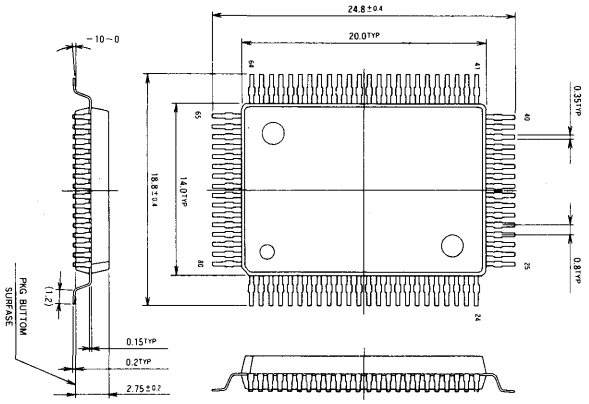
(Condition: Ta = + 25℃, VDD=5.0±0.)

Electrical Characteristics

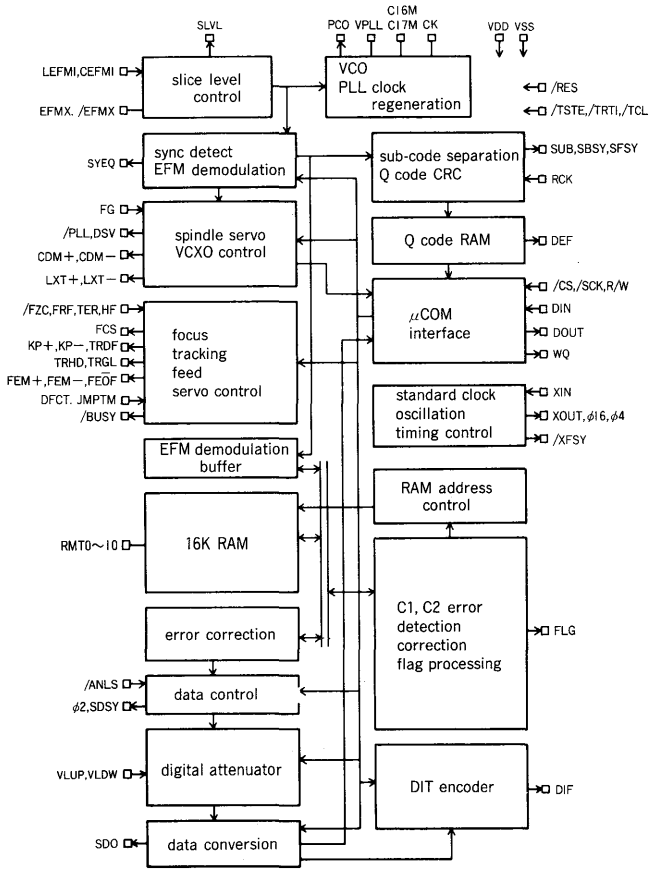
Item	Symbol	Condition	Minimum	Typical	Maximum	Unit	Remarks
Power supply voltage	IDD	VDD=5V				mA	
Output voltage H level	VOH	IOL=20μA	4.0			V	
Output voltage L level	VOL	IOL=1mA			0.4	V	
Input voltage H level (1)	VIH1		3.5			V	Note1
Input voltage L level (1)	VIL1				1.5	V	Note1
Input voltage H level (2)	VIH2		2.0			V	Note2
Input voltage L level (2)	VIL2				0.8	V	Note2

Note1: Must be applied for other terminals than those given in Note2.
Note2: Must be applied for /CS, DIN, / SCK, R/W terminals.

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



DIGITAL AUDIO

Signal Processor & Controller for Compact Disk Player

YM3805 SPC

■ OUTLINE

The YM3805 is a compact disc player signal processor (SGP) and servo controller CMOS LSI developed by Yamaha.

The YM3805 carries out the digital filtering and other signal processing useful for optical pick-up EFM signal demodulation and erroneous signal detection and correction and improved audio quality, as well all servo control (e. g., focus, disc, tracking, feed).

It is used in conjunction with the special serial input DAC YM3015 or YM3020.

■ FUNCTIONS

1. Simple external connection of a crystal activates reference clock oscillations and the necessary internal timing signals.
2. Digitalizes the EFM signal, and based on that carries out clock regeneration and synchronizing signal isolation.
3. EFM demodulates this digital signal.
4. Isolates the Q sub-code from the EFM demodulated signal, and after carrying out a CRC check, outputs it to an external microprocessor.
5. Outputs a frame phase difference signal derived from the regenerated clock and the reference clock and controls the rotation speed of the disc motor.
6. Carries out tracking as well as feed servo control for calling up the beginning of a selection and for fast forward, etc., upon input of a command from an external microprocessor.
7. Uses EFM demodulated signal buffering to absorb fluctuations in the rotation of the disc and interfaces the external RAM and signals (±4 frame jitter absorption).
8. Carries out unscrambling and de-interleaving of EFM demodulated signals in a set order.
9. Detects erroneous signals and corrects them and performs flag processing as well (double-error correction).
   Performs signal compensation, hold, and even muting.
10. Carries out digital filtering (signal break at 20 KHz) by doubling the sampling period (88.2 KHz for both the left and right channels), outputting a DAC signal. (Modes in which digital filtering is not carried out are also available.)

■ FEATURES

1. Silicon gate CMOS construction
2. 80 pin flat plastic package (saves space)
3. 5 V single power supply

■ ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

ITEM	SYMBOL	RATING	UNITS
Supply voltage	V_{DD}	−0.3 ~ +7.0	V
Input voltage	V_I	−0.3 ~ V_{DD} +0.5	V
Operating temperature	Top	−20 ~ +75	°C
Storage temperature	Tstg	−50 ~ +125	°C

Recommended Operating Conditions

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNITS
Supply voltage	V_{DD}	4.75	5.00	5.25	V
Operating temperature	Top	0	25	75	°C

Electrical Characteristics

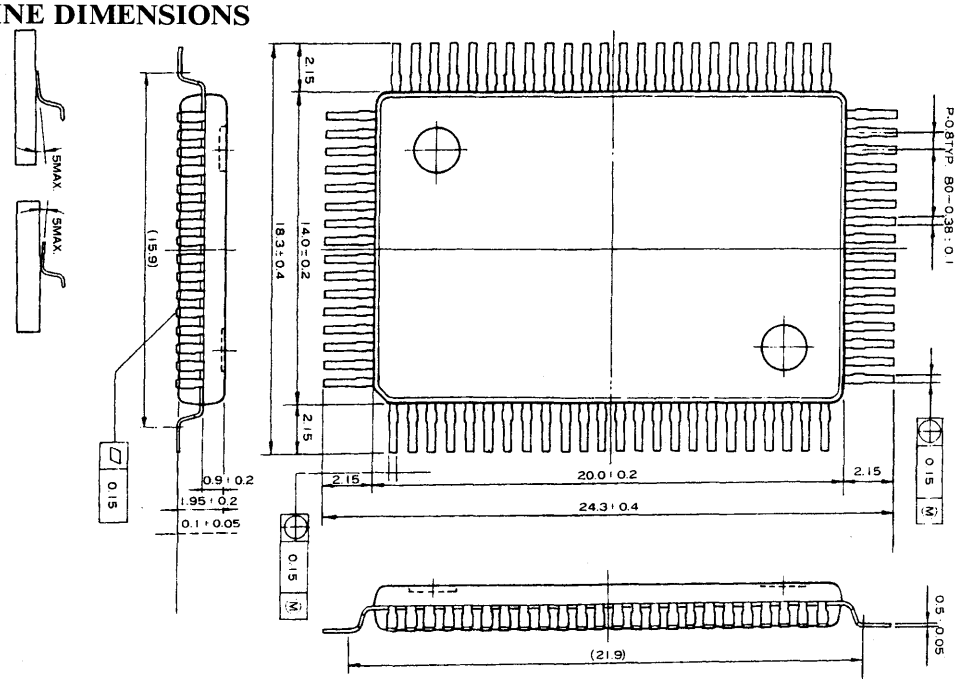
ITEM	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	REMARKS
Supply current	I_{DD}	V_{DD} = 5V		25	40	mA	
Output high level voltage	V_{OH}	I_{OH} = 20μA	4.0			V	
Output low level voltage	V_{OL}	I_{OL} = 1 mA			0.4	V	
Input high level voltage (1)	V_{IH1}		3.5			V	(Note 1)
Input low level voltage (1)	V_{IL1}				1.5	V	(Note 1)
Input high level voltage (2)	V_{IH2}		2.0			V	(Note 2)
Input low level voltage (2)	V_{IL2}				0.8	V	(Note 2)
Input leakage current	I_{LK}	V_I = 5V			10	μA	

Condition: V_{DD} = 5.0V±5%, Top = +0 ~ 70°C

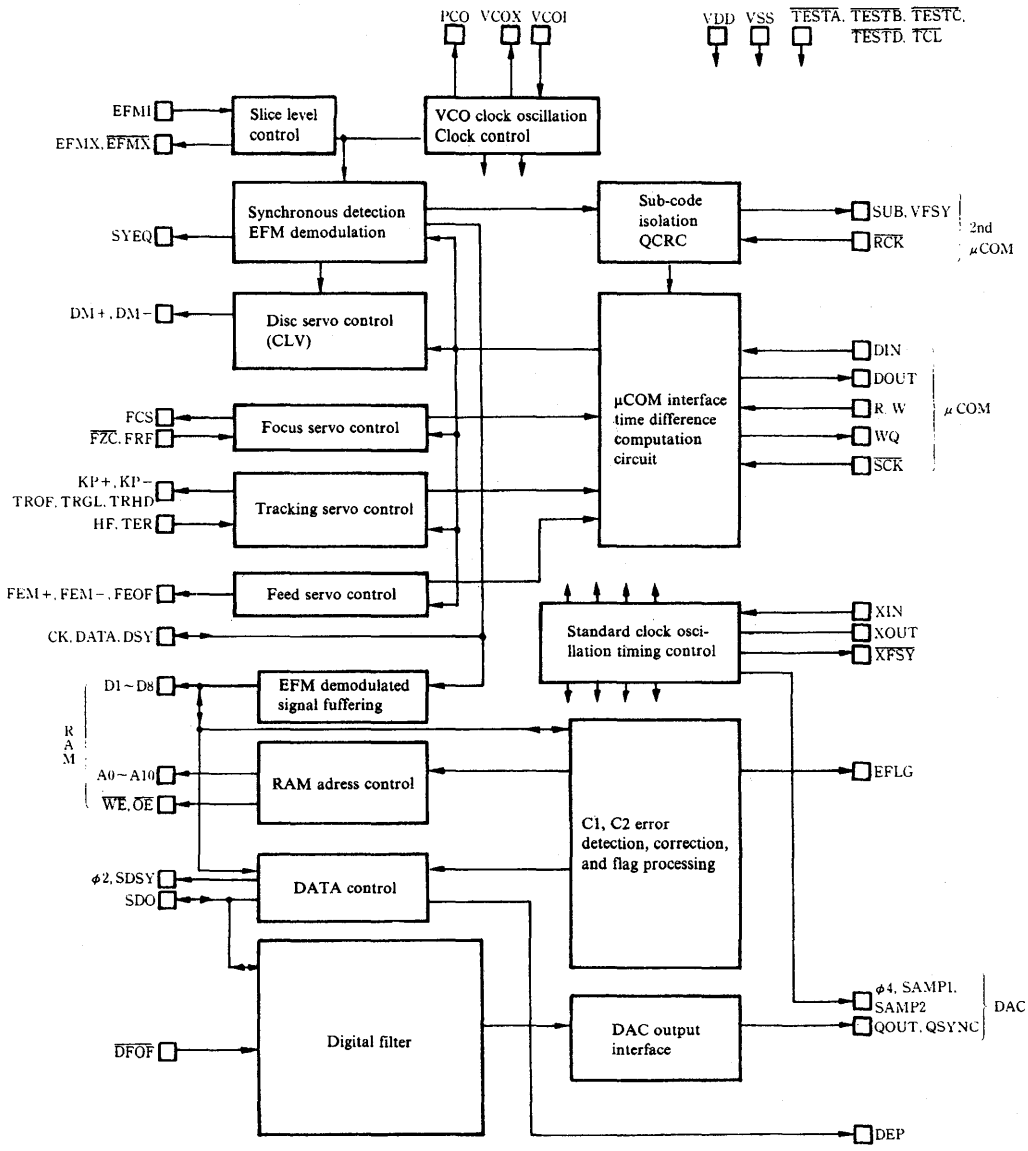
Note 1: Applicable to terminals 3.VCOI 8.EFMI 14.$\overline{FZC}$ 15.FRF 16.HF 17.TER.

Note 2: Applicable to terminals 33.$\overline{RCK}$ 38.DIN 39.$\overline{SCK}$ 54.D8- 61.D1.

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



DIGITAL AUDIO

Signal Processor & Controller for Compact Disc Player

YM3815-H SPC-B

■ OUTLINE

The YH3815-H is a compact disc player signal processor (SGP) and servo controller CMOS LSI developed by Yamaha.

The YM3815-H carries out the digital filtering and other signal processing useful for optical pick-up EFM signal demodulation and erroneous signal detection and correction and improved audio quality, as well all servo control (e. g., focus, disc, tracking, feed).

It is used in conjunction with the serial input DAC PCM56 or PCM57(Burr-Brown)

■ FUNCTIONS

1. Simple external connection of a crystal activates reference clock oscillations and the necessary internal timing signals.
2. Digitalizes the EFM signal, and based on that carries out clock regeneration and synchronizing signal isolation.
3. EFM demodulates this digital signal.
4. Isolates the Q sub-code from the EFM demodulated signal, and after carrying out a CRC check, outputs it to an external microprocessor.
5. Outputs a frame phase difference signal derived from the replayed clock and the reference clock and controls the rotation speed of the disc motor.
6. Carries out tracking as well as feed servo control for calling up the beginning of a selection and for fast forward, etc., upon input of a command from an external microprocessor.
7. Uses EFM demodulated signal buffering to absorb fluctuations in the rotation of the disc and interfaces the external RAM and signals (±4 frame jitter absorption).
8. Carries out unscrambling and de-interleaving of EFM demodulated signals in a set order.
9. Detects erroneous signals and corrects them and performs flag processing as well (double-error correction).
   Performs signal compensation, hold, and even muting.
10. Carries out digital filtering (signal break at 20 KHz) by doubling the sampling period (88.2 KHz for both the left and right channels), outputting a DAC signal. (Modes in which digital filtering is not carried out are also available.)

■ FEATURES

1. Silicon gate CMOS construction
2. 80 pin flat plastic package (saves space)
3. 5 V single power supply

■ ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

ITEM	SYMBOL	RATING	UNITS
Supply voltage	V_{DD}	−0.3 ~ +7.0	V
Input voltage	V_I	−0.3 ~ V_{DD} +0.5	V
Operating temperature	Top	−20 ~ +75	°C
Storage temperature	Tstg	−50 ~ +125	°C

Recommended Operating Conditions

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNITS
Supply voltage	V_{DD}	4.75	5.00	5.25	V
Operating temperature	Top	0	25	75	°C

Electrical Characteristics

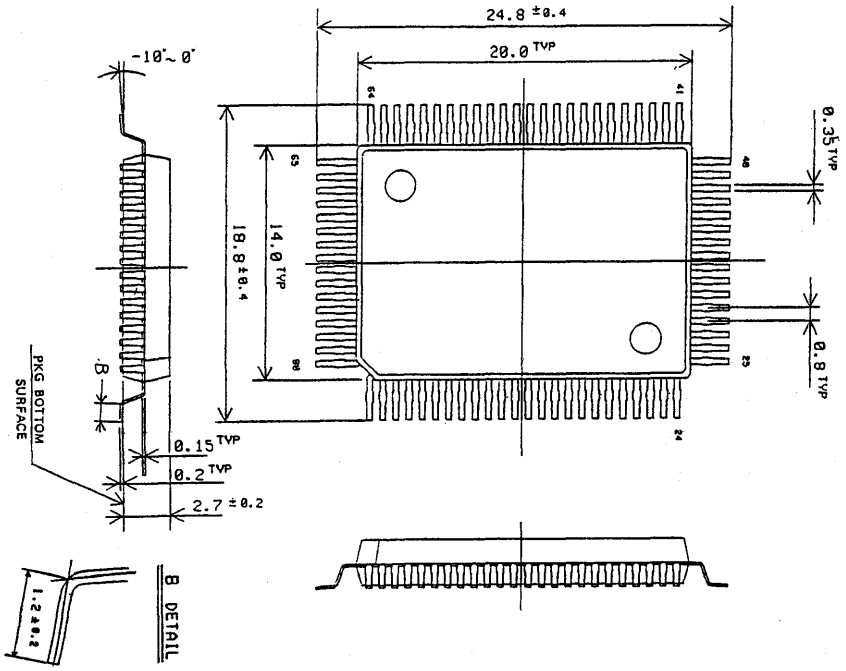
ITEM	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	REMARKS
Supply current	I_{DD}	V_{DD} = 5V		25	40	mA	
Output high level voltage	V_{OH}	I_{OH} = 20μA	4.0			V	
Output low level voltage	V_{OL}	I_{OL} = 1 mA			0.4	V	
Input high level voltage (1)	V_{IH1}		3.5			V	(Note 1)
Input low level voltage (1)	V_{IL1}				1.5	V	(Note 1)
Input high level voltage (2)	V_{IH2}		2.0			V	(Note 2)
Input low level voltage (2)	V_{IL2}				0.8	V	(Note 2)
Input leakage current	I_{LK}	V_I = 5V			10	μA	

Condition: V_{DD} = 5.0V±5%, Top = +0 ~70°C

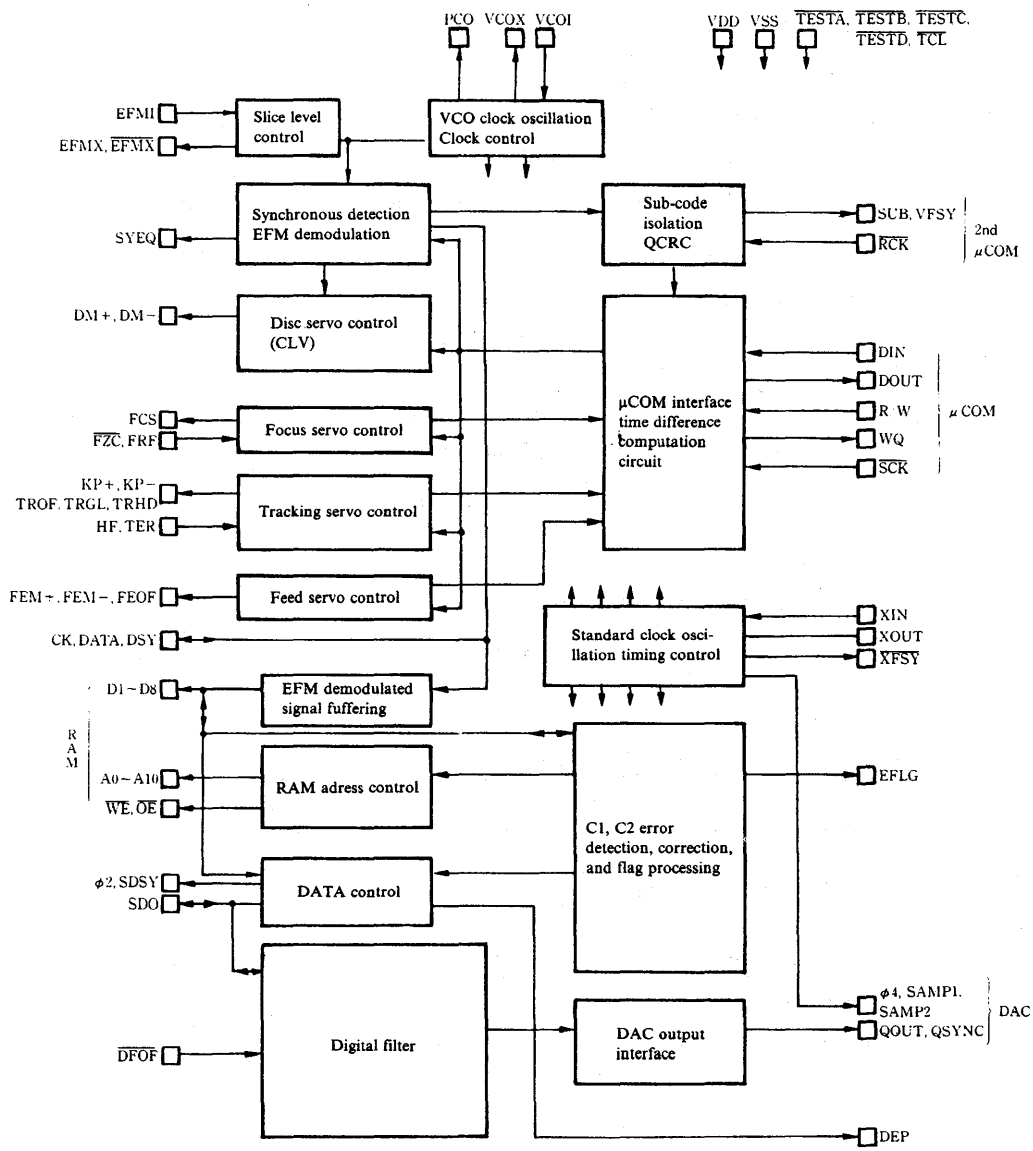
Note 1: Applicable to terminals 3.VCOI 8.EFMI 14.$\overline{FZC}$ 15.FRF 16.HF 17.TER.

Note 2: Applicable to terminals 33.$\overline{RCK}$ 38.DIN 39.$\overline{SCK}$ 54.D8- 61.D1.

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



DIGITAL AUDIO

Digital Audio Interface Transmitter

YM3613C DIT

■ OUTLINE

The YM3613C is an LSI device used for signal processing in order to output Digital audio signals of a CD player to the external equipment. Digital signal output to the external world enables Digital Audio Interface Format signals to be output without requiring a special externally-mounted circuit. This YM3613C has a built-in PLL (Phase-Locked Loop) circuit, which synchronizes the sampling frequency that is input to this LSI device to 44.1KHz.

■ FUNCTIONS AND FEATURES

1) Reference clock output and internally required Timing signals can all be generated by merely connecting a liquid crystal.
2) The YM3613C has a function for switching the format of the 16-bit serial voice signal input, so that the data can be output using the Digital Audio Interface format regardless of whether it was input started from the MSB or LSB.
3) Its built-in PLL circuit outputs clocks of a central 8.6436MHz frequency in accordance with the input frequency of the WCI pin.
4) The YM3613C outputs the External Digital signals of the Digital Audio Interface format.
5) The Subcode input terminal permits Subcode data to be read automatically.
6) Since the "Q" bit of Subcode data is subjected to a CRC (Cyclic Redundancy Code) check, the Channel status of the Digital Audio Interface is affected only when the CRC check on the "Q" bit tests positive.
7) Silicon gate CMOS construction (low power consumption)
8) 24-pin Dual-Inline Package (DIP)
9) +5V power supply

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

Item	Symbol	Rating	Units
Supply voltage	V_{DD}—V_{SS}	−0.3 ~ +7.0	V
Input voltage	V_I	V_{SS} − 0.3 ~ V_{DD} + 0.5	V
Operating temperature	T_{OP}	−20 ~ +75	°C
Storage temperature	Tstg	−50 ~ +125	°C

2. Recommended Operating Conditions

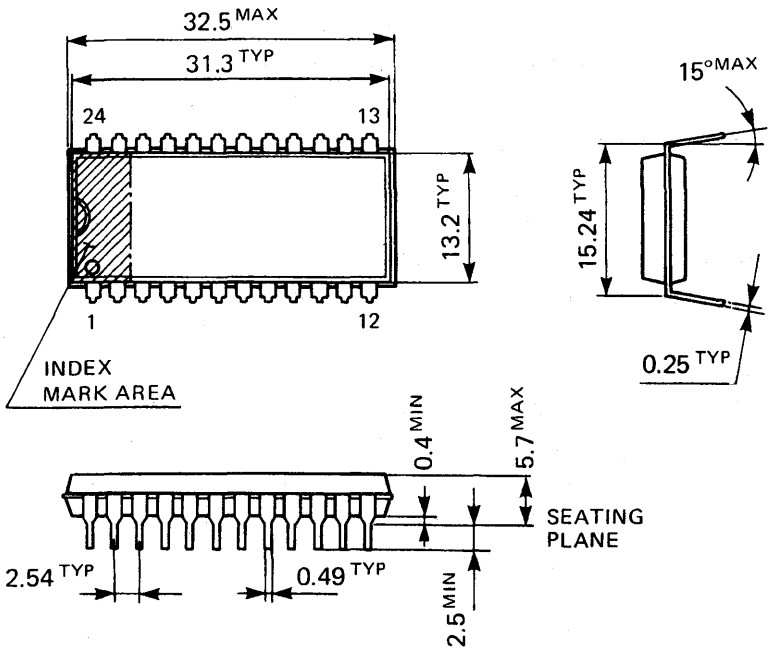
Item	Symbol	Min.	Typ.	Max.	Units
Supply voltage	V_{DD}—V_{SS}	4.5	5.00	5.5	V

3. Electrical Characteristics

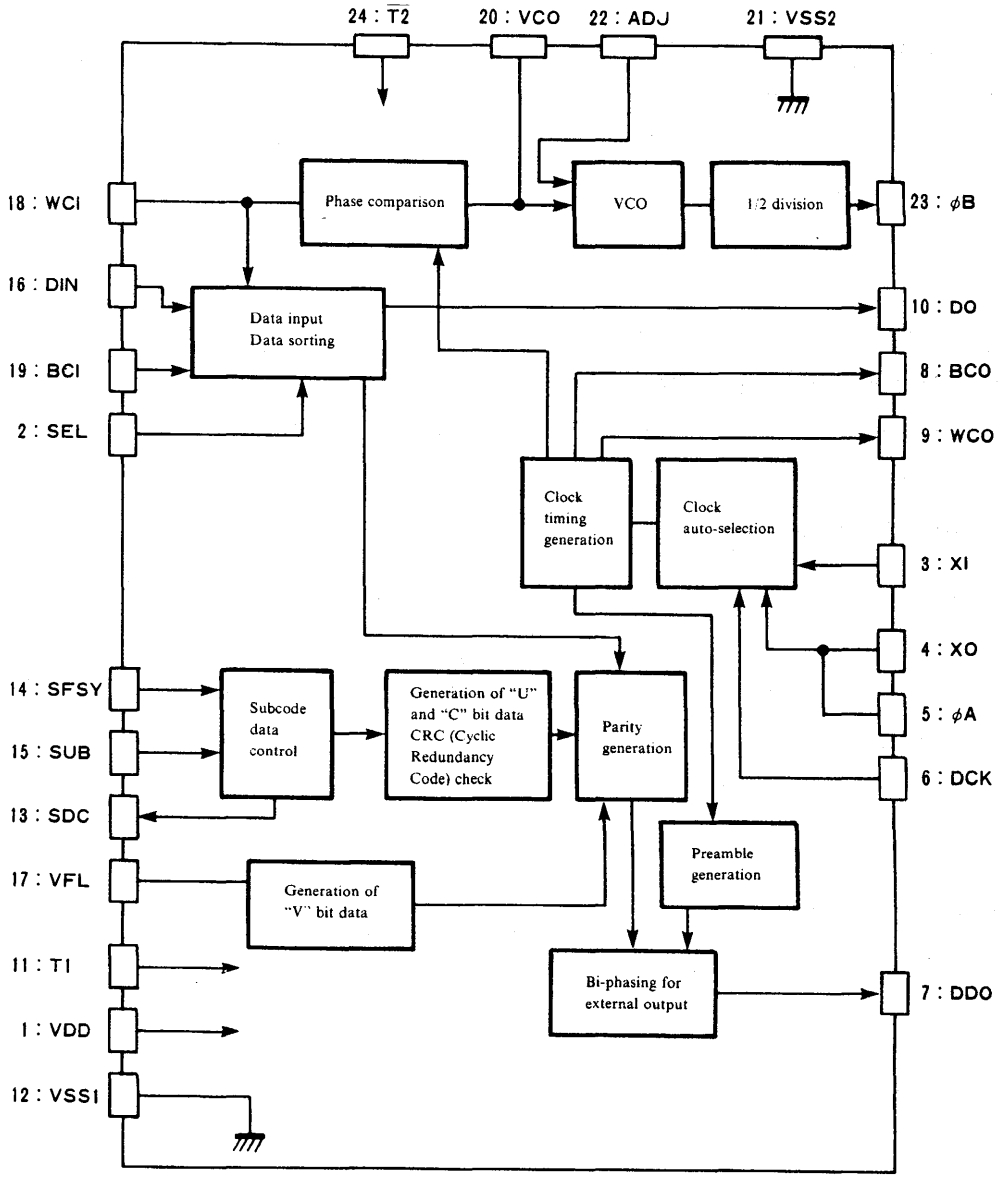
Item	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating current	I_{DD}	V_{DD} = 5V fc = 16.9344MHz		10	18	mA
High-level output voltage	V_{OH}	I_{OH} = 0.4mA	4.0			V
Low-level output voltage	V_{OL}	I_{OL} = 2mA			0.4	V
High-level input voltage	V_{IH}	XI pin excluded XI pin	2.0 3.0			V
Low-level input voltage	V_{IL}				0.8	V
Input leakage current	I_{LK}	V_I = 5V			10	μA

NOTE: The analog VCO pin and the ADJ pin are excluded.

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



DIGITAL AUDIO

Digital Audio Interface Receiver

YM3623B DIR

■ OUTLINE

The YM3623B is an LSI device, which receives and plays back the Digital Audio Interface Format signals that are transferred between digital audio equipment. Use of the YM3623B eliminates the need for a special externally- mounted circuit for playback, thereby greatly facilitating the playback of Digital Audio signals.

■ FUNCTIONS

1) The YM3623B has an internal PLL circuit which synchronizes with the Digital Audio Format signals that are sent in from the external equipment.
2) It outputs Audio signals starting with the MSB (Most Significant Bit). In sync with that output, it outputs the Timing clocks for the D/A output sample-and-hold operations and the signals indicating the L or R channel.
3) It has a terminal for outputting a Subcode, making possible the retrieval of Subcode data.
4) It is capable of outputting the sampling frequency, Emphasis ON/OFF status, Copy Enable/Disable status, as well as the Error status of transmitted Audio signals.
5) In case an error is detected in the Digital Audio Interface Format signals, the Audio data preceding the detected error is output again.

■ FEATURES

1) Silicon gate CMOS construction (low power consumption)
2) 28-pin Dual-Inline Package (DIP)
3) +5V power supply

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

Item	Symbol	Rating	Units
Supply voltage	V_{DD}—V_{SS}	−0.3 ~ +7.0	V
Input voltage	V_I	V_{SS} − 0.3 ~ V_{DD} + 0.5	V
Operating temperature	T_{OP}	−20 ~ +75	°C
Storage temperature	Tstg	−50 ~ +125	°C

2. Recommended Operating Conditions

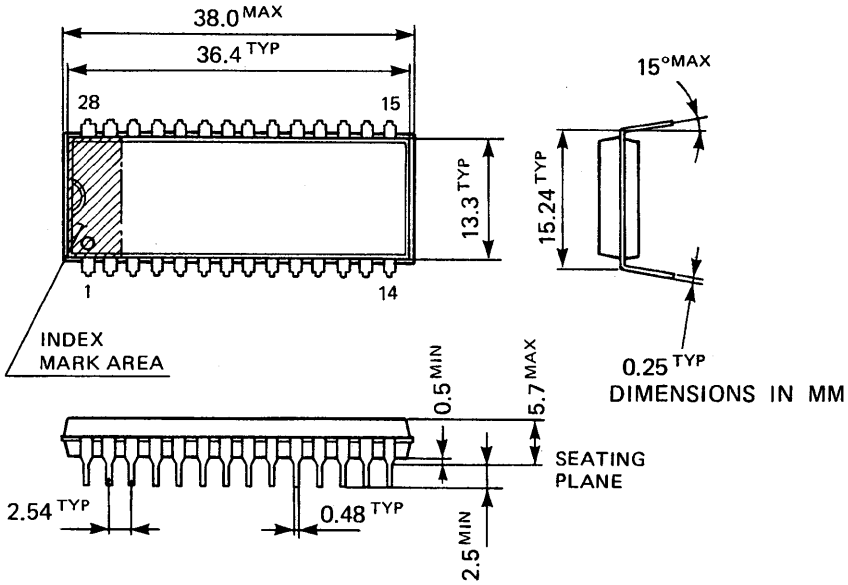
Item	Symbol	Min.	Typ.	Max.	Units
Supply voltage	V_{DD}—V_{SS}	4.75	5.00	5.25	V

3. Electrical Characteristics

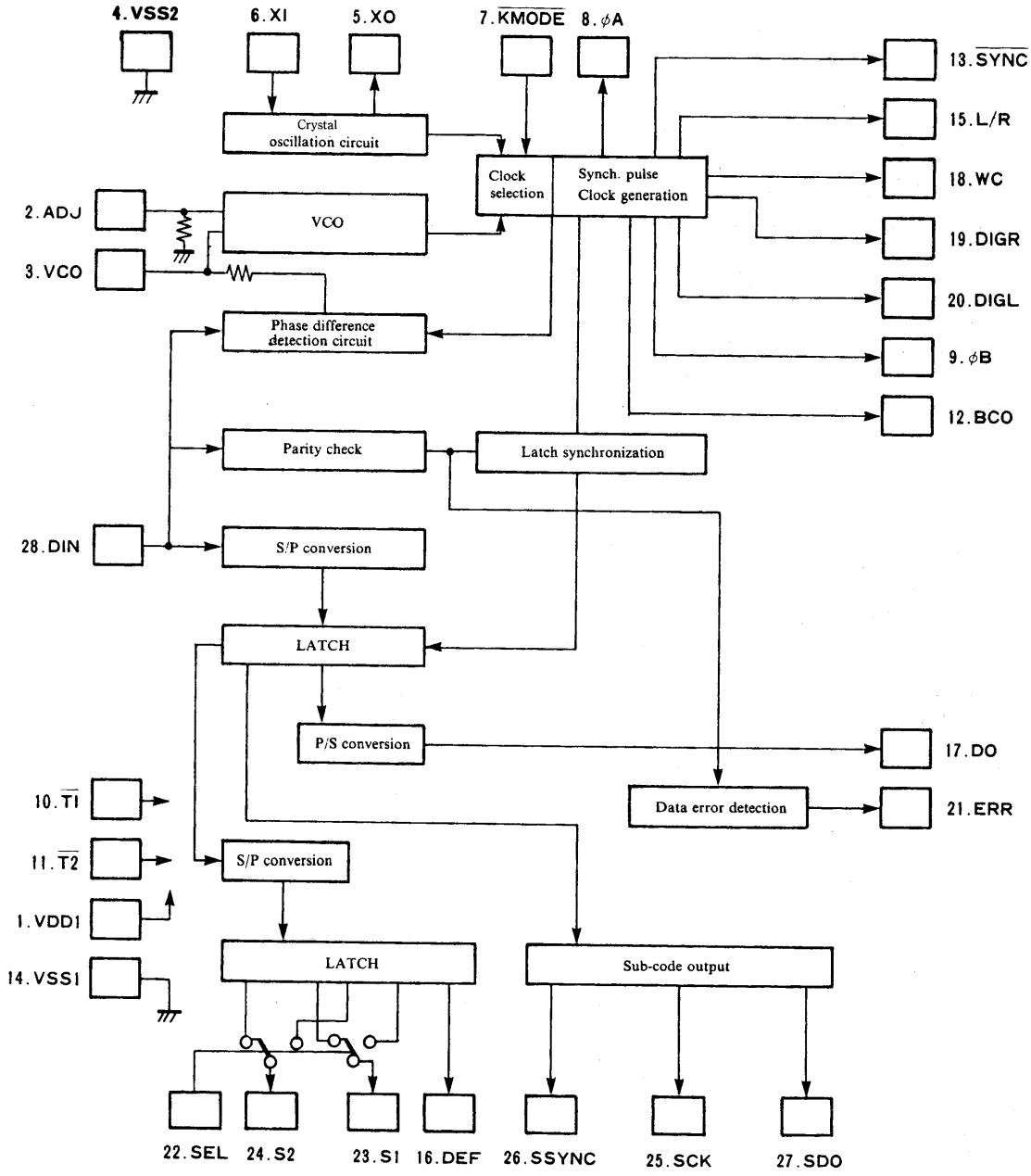
Item	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating current	I_{DD}	V_{DD} = 5V D_{IN} = 5V fc = 16.9344MHz		6	8	mA
High-level output voltage	V_{OH}	I_{OH} = 0.4mA	4.0			V
Low-level output voltage	V_{OL}	I_{OL} = 2mA			0.4	V
High-level input voltage	V_{IH}	X_I pin excluded X_I pin	2.0 4.5			V
Low-level input voltage	V_{IL}				0.8	V
Input leakage current	I_{LK}	V_I = 5V			10	μA

NOTE: The analog VCO pin and the ADJ pin are excluded.

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



DIGITAL AUDIO

2-Channel 4-times Oversampling Digital Filter

YM3404B CDDF

■ OUTLINE

The YM3404B (CDDF) is a super-high performance 4-times oversampling digital filter for use with the digital audio systems developed by Yamaha.

It is connectable directly to LSI, DIT, DIR, etc. for digital audio systems, and can exhibit its excellent performance through simple procedures.

■ FEATURES

- 4-times oversampling in two channels
- Linear phase FIR type filters connected in two vertical stages
  - 1'st filter: 225-order FIR filter
  - 2'nd filter: 41-order FIR filter
- 19 × 18 bits multiplier built in
- Floating point multiplier and accumlater having a coefficient of 18 bits
- Overflow limiter built in
- Filter characteristics (fs=44.1 kHz)
  - Pass band ripple: Within ±0.0001 dB at 0 to 20 kHz
    (Within quantization error in 16 bits)
  - Stop band attenuation: At least 100 dB at 24.1 to 64.1 kHz
    At least 99 dB at 64.1 kHz and higher
- High precision oscillator specially designed for use with the filter
- Clock providing 8.6426 MHz output
- C-MOS type process
- Single 5 V power supply
- 16-pin type DIP package

■ ELECTRICAL CHARACTERISTICS

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Minimum	Maximum	Unit
Power supply voltage	Vdd	−0.3	+7.0	V
Input voltage	VI	−0.3	Vdd+0.5	V
Working temperature	Top	−20	+75	°C
Storage temperature	Tstg	−50	+125	°C

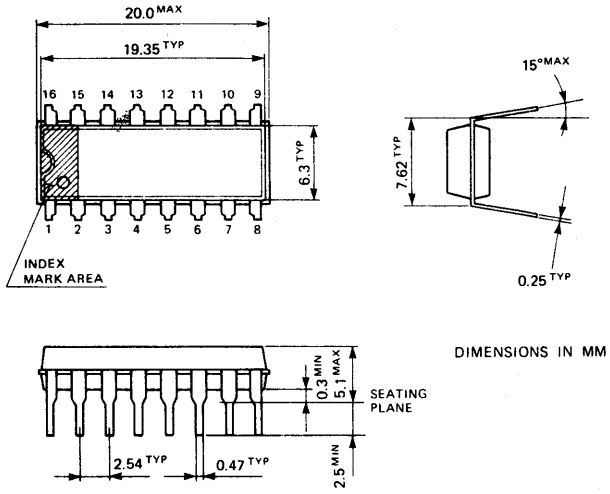
■ RECOMMENDED OPERATING CONDITIONS

Item	Symbol	Minimum	Typical	Maximum	Unit
Power supply voltage	VDD	4.75	5.0	5.25	V
Clock frequency	XIN	12.2	16.93	18.5	MHz
Working temperature	Top	0	25	70	°C

■ ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{DD}=5±0.25V)

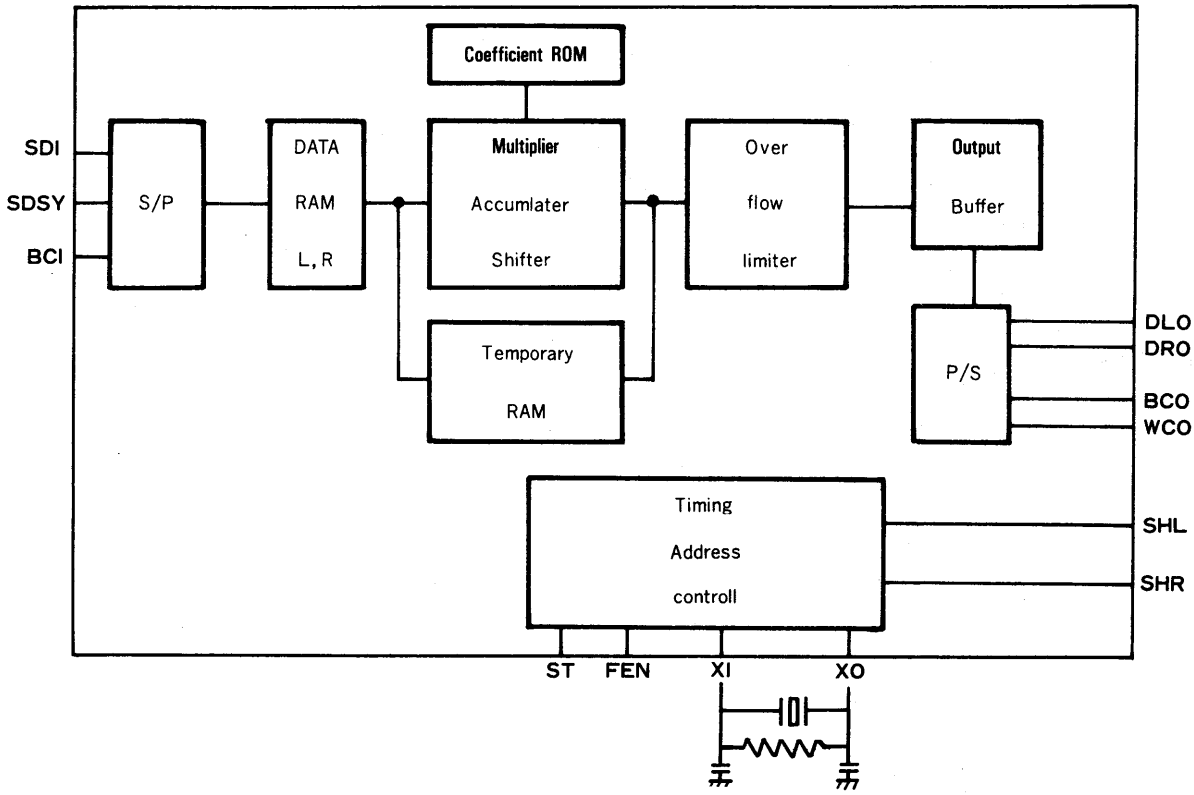
Item	Symbol	Condition	Minimum	Typical	Maximum	Unit
Power consumption	W	Vdd=+5V		200	270	mW
Input voltage H level (XI, FEN, ST) (BCI, SDSY, SDI)	VIH		 3.5 2.7		 Vdd Vdd	 V V
Input voltage L level	VIL		0		0.8	V
Output voltage H level	VOH		2.4		Vdd	V
Output voltage L level	VOL		0		0.4	V
Output delay (delay from BCO)			5		35	nsec
Input data setup time (Rise of BCI)			50			nsec
Input data hold time (Rise of BCI)			20			nsec
XI ON/OFF time (Duty)				50		%
BCI ON/OFF time (Duty)				50		%

■ OUTLINE DIMENSIONS



DIMENSIONS IN MM

■ BLOCK DIAGRAM



DIGITAL AUDIO

2-Channel 8-times Oversampling Digital Filter

YM3414 ACDDF

■ OUTLINE

The YM3414 (ACDDF) is a super-high performance 8-times oversampling digital filter for use with the digital audio systems developed by Yamaha.

It is connectable directly to LSI, DIT, DIR, etc. for digital audio systems, and can exhibit its excellent performance through simple procedures.

■ FEATURES

- 8-times oversampling in two channels
- Linear phase FIR type filters connected in three vertical stages
  - 1'st filter: 225-order FIR filter
  - 2'nd filter: 41-order FIR filter
  - 3'rd filter: 21-order FIR filter
- 19 × 18 bits multiplier built in
- Floating point multiplier and accumlater having a coefficient of 18 bits
- Overflow limiter built in
- Filter characteristics (fs=44.1 kHz)
  - Pass band ripple: Within ±0.0001 dB at 0 to 20 kHz
    (Within quantization error in 16 bits)
  - Stop band attenuation: At least 100 dB at 24.1 kHz and higher
- High precision oscillator specially designed for use with the filter
- C-MOS type process
- Single 5 V power supply
- 16-pin type DIP package

■ ELECTRICAL CHARACTERISTICS

■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Minimum	Maximum	Unit
Power supply voltage	VDD	−0.3	+7.0	V
Input voltage	VI	−0.3	Vdd+0.5	V
Working temperature	Top	−20	+75	°C
Storage temperature	Tstg	−50	+125	°C

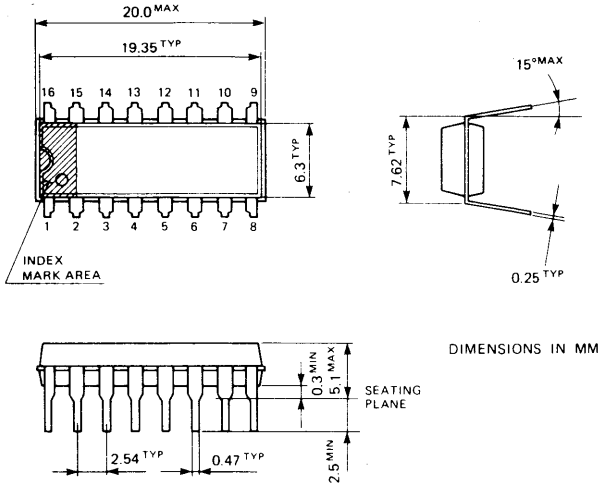
■ RECOMMEND OPERATING CONDITIONS

Item	Symbol	Minimum	Typical	Maximum	Unit
Power supply voltage	VDD	4.75	5.0	5.25	V
Clock frequency	XIN	12.2	16.93	18.5	MHz
Working temperature	Top	0	25	70	°C

■ ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{DD}=5± 0.25V)

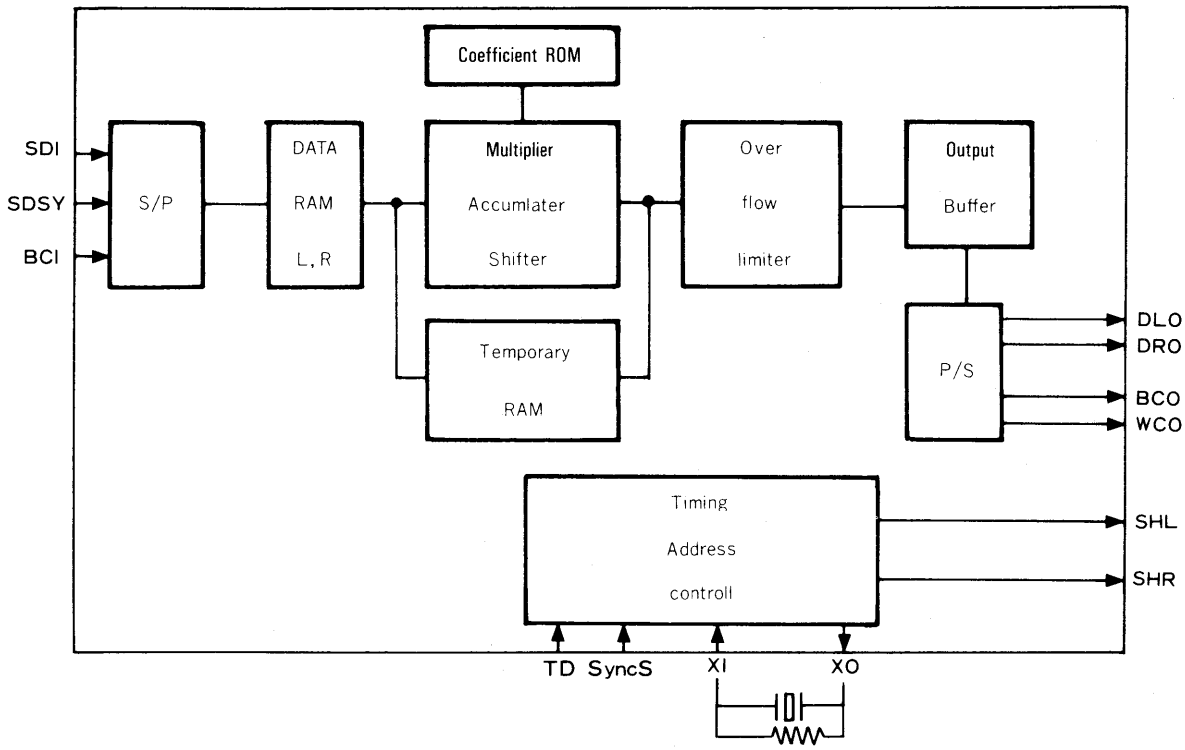
Item	Symbol	Condition	Minimum	Typical	Maximum	Unit
Power consumption	W	Vdd=+5V		200	270	mW
Input voltage H level (XI, TD) (BCI, SDSY, SDI, SyncS)	VIH		 3.5 2.7		 Vdd Vdd	 V V
Input voltage L level	VIL		0		0.8	V
Output voltage H level	VOH		2.4		Vdd	V
Output voltage L level	VOL		0		0.4	V
Output delay (delay from BCO)			5		35	nsec
Input data setup time (Rise of BCI)			50			nsec
Input data hold time (Rise of BCI)			20			nsec
XI ON/OFF time (Duty)				50		%
BCI ON/OFF time (Duty)				50		%

■ OUTLINE DIMENSIONS



DIMENSIONS IN MM

■ BLOCK DIAGRAM



DIGITAL AUDIO

2-Channel 8-times Oversampling Digital Filter

YM3434 AFUDF

■ OUTLINE

The digital filter's own system clock rate must be considerably faster than the input bit clock rate and at the same time synchronism is required in the system as a whole. Thus what is normally required is a high-speed clock which is synchronous with the signal handling pre-processor. Then the major application problem is how to interface these different clock rates.

YM3434 is a high quality 2-channel 8-times oversampling digital filter which has been developed to solve such problems. It can be used easily as an interface in a wide range of digital audio systems. Its filtering capabilities are equivalent to the YM3414.

Since the system clock of this LSI can be different from the serial input signal and it operates normally at any clock rate above 400 clocks for each input sampling frequency (fs), it is not necessary to change the clock rate even if the sampling frequency is changed.

For example, by connecting a 20MHz crystal oscillator, there is no need to change the clock rate even when the sampling frequency is changed to 32KHz, 44.1KHz or 48KHz.

■FEATURES

- Operation at an independent system clock from the serial input signal
- Input signals can be handled at any of the following input bit clock rates without adding any circuit: 32fs, 48fs, 64fs, 80fs, 96fs, 112fs, 128fs, 144fs, 160fs, 176fs, and 192fs,
- Capable to cope with sampling frequencies 32KHz, 44.1KHz and 48KHz.
- Linear phase FIR type filters connected in three vertical stages
  1st filter : 225-order FIR filter
  2nd filter: 41-order FIR filter
  3rd filter : 21-order FIR filter
- Built-in 19 × 18 bit multiplier, floating point calculation with a coefficient of 18 bits
- Built-in overflow limiter
- Filter characteristics (at 8-times)
  Pass band ripple : Within ±0.0001dB at 0 to 0.4535 × fs
  Stop band attenuation : At least 100dB at 0.5465 × fs to 7.4535 × fs
- Output data switchable between 16 bit and 18 bit (directly connectable to PCM56 and PCM58).
- Switchable between 1 DAC (4-times) and 2 DAC (8-times).
- C-MOS type processor, Single 5 V power supply, 16-pin type DIP package.

■ ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Item	Symbol	Minimum	Maximum	Unit
Power supply voltage	V_{DD}	−0.3	+7.0	V
Input voltage	VI	−0.3	V_{DD}+0.5	V
Working temperature	Top	−20	+75	°C
Storage temperature	Tstg	−50	+125	°C

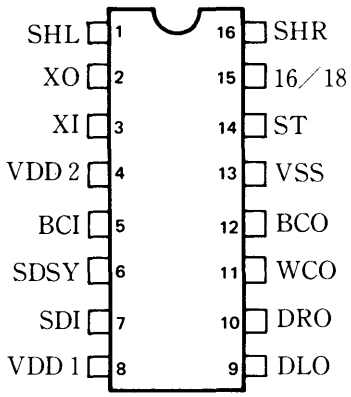
Recommended Operating Conditions

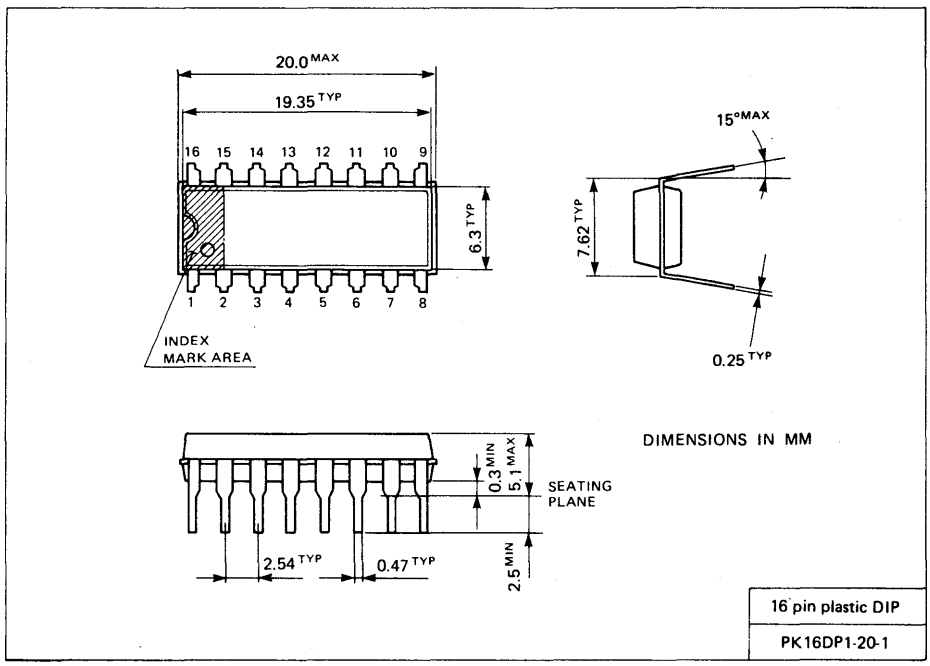
Item	Symbol	Minimum	Typical	Maximum	Unit
Power supply voltage	V_{DD}	4.75	5.00	5.25	V
Clock frequency	XIN	12.2	(400 Fs)	20.0	MHz
Working temperature	Top	0	25	+70	°C

Electrical Characteristics

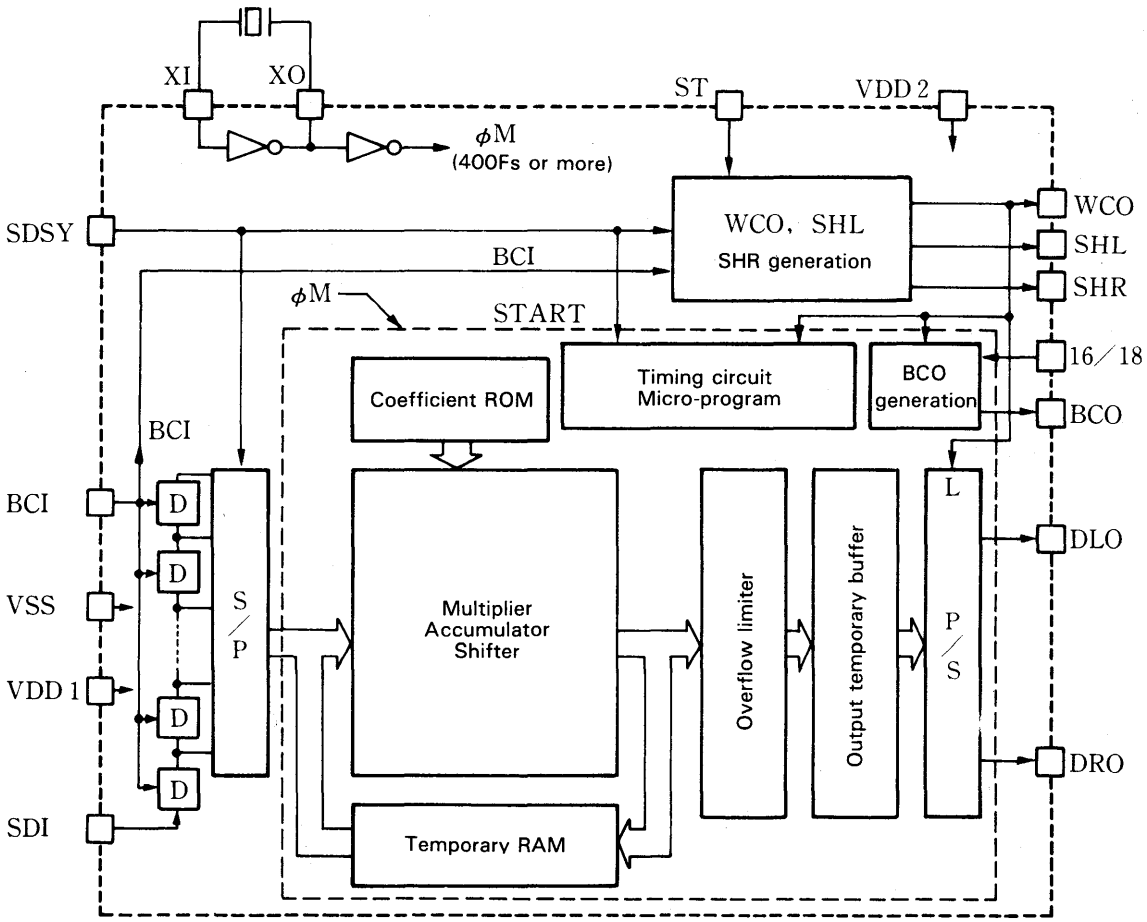
Item	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Power consumption	W	V_{DD}=+5V			300	mW
Input voltage H level (XI, 16/18, ST) (BCI, SDSY, SDI)	VIH		 3.5 2.7		 V_{DD} V_{DD}	 V V
Input voltage L level	VIL		0		0.8	V
Output voltage H level	VOH		2.4		V_{DD}	V
Output voltage L Level	VOL		0		0.4	V
DLO, DRO setup time DLO, DRO hold time			15 15			ns ns
Input data setup time (Rise of BCI)			50			ns
Input data hold time (Rise of BCI)			20			ns
XI ON/OFF time (Duty)				50		%
BCI ON/OFF time (Duty)				50		%

■ OUTLINE DIMENSIONS





■ BLOCK DIAGRAM



DIGITAL AUDIO

2 channel 8 times oversampling digital filter operates via serial input signal and independent system clock.

YM3433 ALCDF

■OUTLINE

This oversampling digital filter operates by repeating the input sample cycle through a sum of products computation process. This calculation must be repeated numerous times for reliable operation. A high speed bit clock rate is required, but only for the part to be oversampled from the input bit clock.

Because of these requirements, the system clock in the digital filter itself operates at a high speed appropriate for the input clock rate. Because it was normal for the cycles to be synchronized by the system, it has been necessary in the past to synchronize the signal processor at the previous step (which received the request) with the high speed clock, and designs used to interface the synchronized high speed clock presented some problems with regard to practical applications.

This LSI chip has solved these problems, resulting in a high grade 2 channel 8 times oversampling digital filter that can be interfaced easily with a wide range of digital audio systems, and it is pin compatible with the YM3434.

This particular LSI chip permits use of a system clock which operates independently from the serial input signal. The input sampling cycle (fs) will operate normally even with input from clocks with more than 400 ticks-for example, even if the sampling frequency is awitched between fs = 32kHz, 44.1kHz, and 48kHz when connected with a 20MHz crystal oscillator, there is no need to switch to any other clock.

■FEATURES

- Because this operates with a serial input signal and an independent system clock, this can handle all of the input bit clock rates which follow with no supplementary circuit: input signals-32 fs, 48 fs, 64 fs, 80 fs, 96 fs, 112 fs, 128 fs, 144 fs, 160 fs, 176 fs, 192 fs.
- Linear phase FIR type filter connected in line at 3 levels
  1st filter: 161 order FIR filter 2nd filter: 33 order FIR filter 3rd filter: 17 order FIR filter
- Built-in overflow limiter
- Filter capacity (when 8-times)
  Passband ripple 0～0.4535× fs: ±0.002 dB or less
  Cutoff band reduced capacity 0.5465×fs ～7.4535×fs: −70dB or more
- 16 bit/18 bit output switching (compatible with PCM56/PCM58)
- 1DAC(4-times)/2DAC(8-times) switching
- CMOS process, +5V power supply, 16 pin plastic DIP

■ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min	Max	Unit
Supply voltage	V_{DD}	−0.3	+7.0	V
Input voltage	V_I	−0.3	V_{DD}+0.5	V
Operating temperature	T_{OP}	−20	+75	℃
Storage temperature	T_{STG}	−50	+125	℃

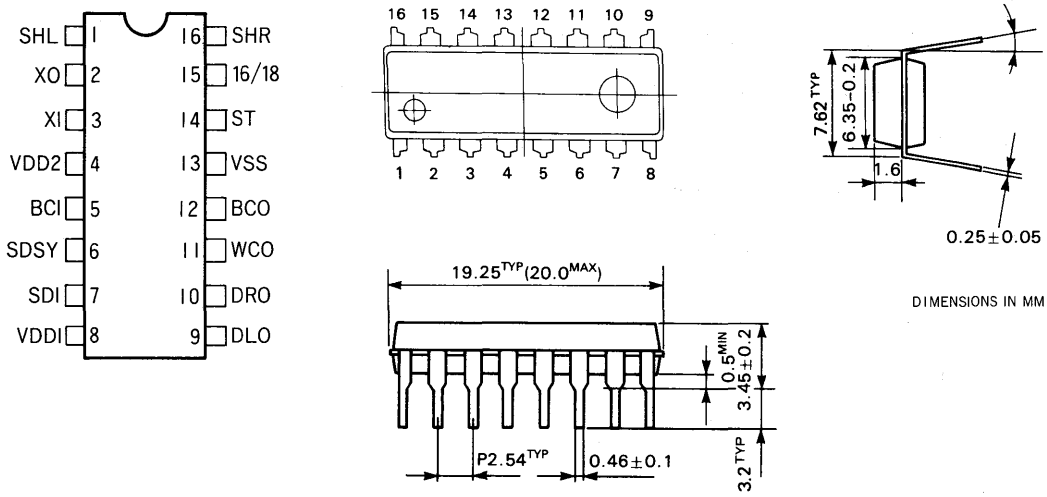
RECOMMENDED OPERATING CONDITIONS

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{DD}	4.75	5.00	5.25	V
Clock frequency	XIN	12.2	(400 fs)	20.0	MHz
Operating temperature	T_{OP}	0	25	+70	℃

ELECTRICAL CHARACTERISTICS (Ta = 25℃, V_{DD} = 5 ± 0.25V)

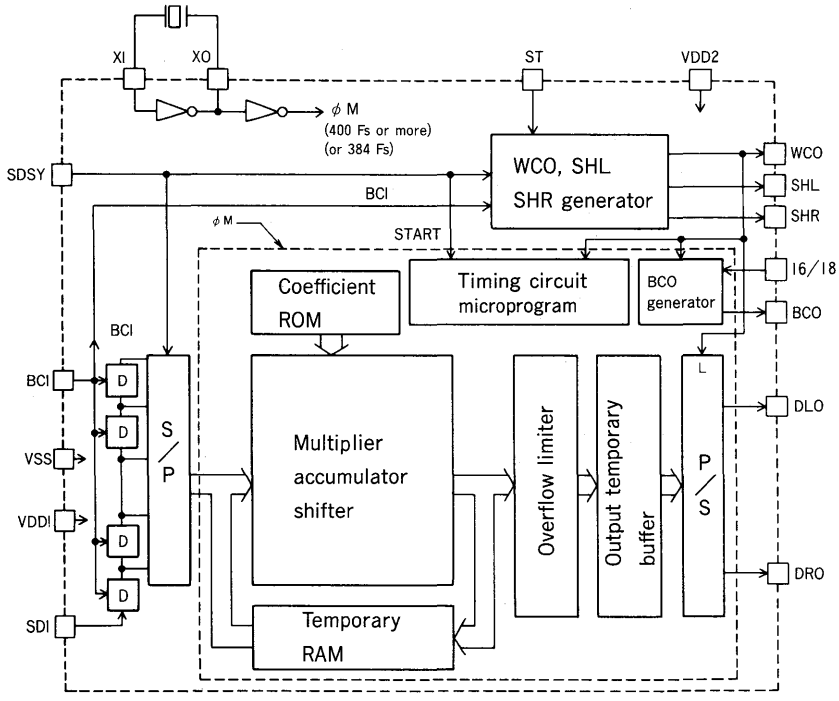
Item	Symbol	Condition	Min	Typ	Max	Unit
Power consumption	W	V_{DD}=+5V			300	mW
High input voltage (XI, 16/18, ST)	V_{IH}		3.5		V_{DD}	V
(BCI, SDSY, SDI)			2.7		V_{DD}	V
Low input voltage	V_{IL}		0		0.8	V
High output voltage	V_{OH}		2.4		V_{DD}	V
Low output voltage	V_{OL}		0		0.4	V
DLO,DRO setup time			15			nS
DLO,DRO hold time			15			nS
Input data setup time (BCI leading edge)			50			nS
Input data hold time (BCI leading edge)			20	20		nS
XI ON/OFF time (Duty)				50		%
BCI ON/OFF time (Duty)				50		%

■ OUTLINE DIMENSIONS



DIMENSIONS IN MM

■ BLOCK DIAGRAM



DIGITAL AUDIO

Digital Equalizer

YM3608 DEQ

■ OUTLINE

The YM3608 is a s pecial digital processor developed by Yamaha Corp. for use with digital filters. This processor makes it possible to easily configure IIR and FIR filters for serial sound signals using the internal microprogram.

This processor also makes possible high accuracy calculations and the freedom to rewrite microprogram functions and coefficients using SCI*.

* SCI: Serial Control Interface (refer to II-2-1)

■ FEATURES

1. All microprogramable function for digital filter.
2. Multiplication is performed with one clock for Data 16 bits × Coefficient 32 bits.
   (2 clocks for Data 32 bits × Coefficient 32 bits)
   (This is 5-clock pipeline processing.)
3. There are 2 serial input terminals and 2 serial output terminals, both of which can be used with any desired timing.
   The MSB/LSB first and shift clocks can be selected independently for input and output. Input and output are also possible using an external clock.
4. A 50-bit accumulator with 4 bits of head margin and overflow detect is provided.
5. The master clock operates at a maximum phase of 4.4MHz and a minimum phase of 2MHz.
6. Microprogram and coefficients can be controlled with SCI (Serial Control Interface).
7. Up to 128 steps can be used with microprogram.
8. Higher calculation performance is possible by making a serial connection to YM3608 (DEQ).
9. Operates on a single 5V power supply.
10. 24-pin DIP.

■ ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Item	Symbol	Rating
Power supply voltage	V_{DD}	−0.3 ~ 7.0V
Input voltage	V_I	−0.3 ~ V_{DD} + 0.5V
Operating temperature	T_{OP}	0 ~ 70°C
Storage temperature	T_{stg}	−50 ~ 125°C

Recommended Operating Conditions

Item	Symbol	Minimum	Typical	Maximum	Unit
Power supply voltage	V_{DD}	4.75	5.00	5.25	V
Operating temperature	T_{OP}	0		70	°C

D.C. Characteristics

Item	Symbol	Minimum	Typical	Maximum	Unit
Input clock frequency	fc	2		4.4	MHZ
Input clock High level time	T_{fh}	90			n sec
Input clock Low level time	T_{fl}	100			n sec
Input data set-up time	T_{DS}	50			n sec
Input data hold time	T_{DH}	10			n sec
Output delay time *1	T_{OD}			100	n sec
Bypass delay time *1	$T_{\beta D}$			70	n sec

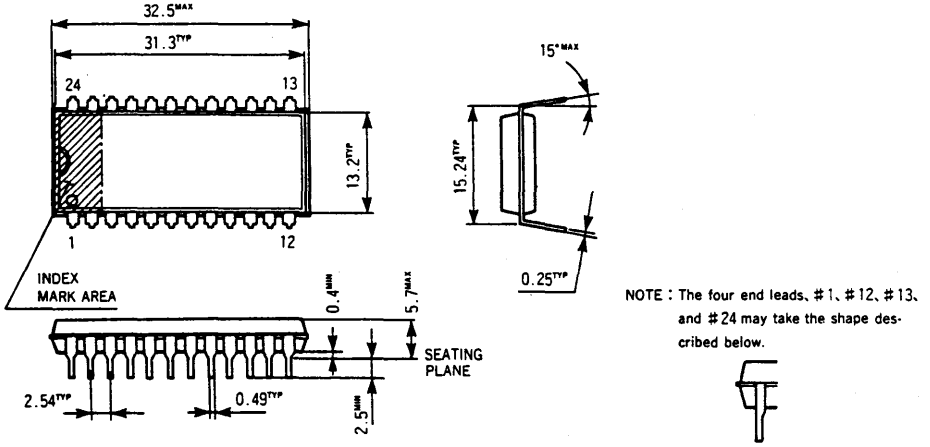
Conditions: V_{DD} = 5.0V ± 5%, T_{OP} = 0 ~ 70°C

A.C. Characteristics

Item	Symbol	Condition	Minimum	Typical	Maximum	Unit
Output voltage H level	V_{OH}	I_{OH} = −0.4mA	3.5		V_{DD}	V
Output voltage L level	V_{OL}	I_{OL} = 1mA	V_{SS}		0.4	V
Input voltage H level	V_{IH}		2.4			V
Input voltage L level	V_{IL}				0.4	V
Input leak current	I_{LK}	V_I = 5V			0.1	μA

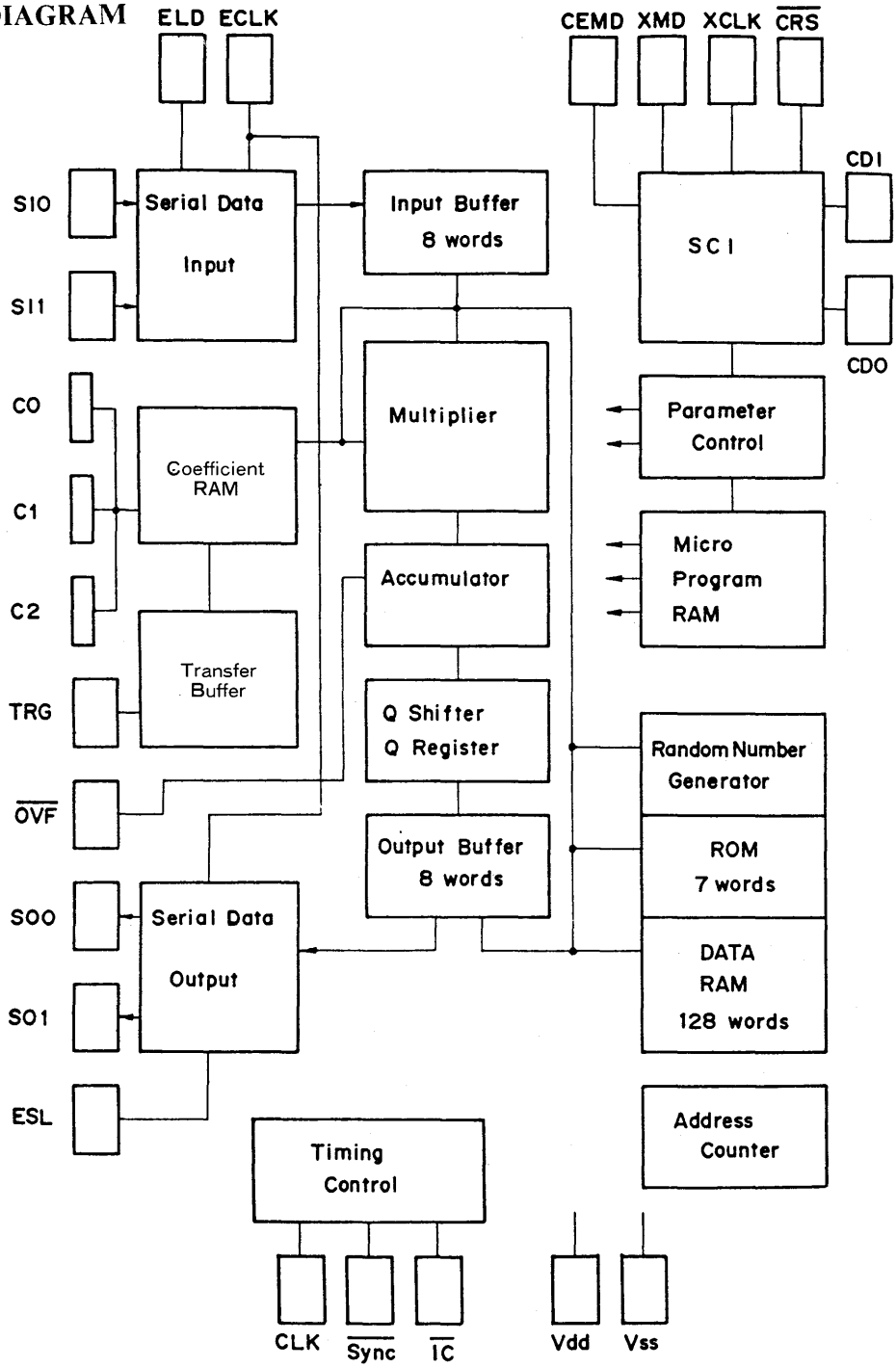
*1: with 100pF capacitance added.

■ OUTLINE DIMENSIONS



NOTE : The four end leads, #1, #12, #13, and #24 may take the shape described below.

■ BLOCK DIAGRAM



DIGITAL AUDIO

Digital Volume

YM3615B DVR

■ OUTLINE

The YM3615B (DVR) is an LSI developed by Yamaha for the control of digital volume in digital audio applications. This LSI can be connected with practically all MSB-first 16-bit LSIs in CD player systems and is provided with digital volume functions over a 330-step range from a minimum level of −66 dB in 0.2 dB steps.

■ FUNCTIONS

- Log-linear digital volume functions can be created by simply supplying pulses to the UP and DOWN terminals.
- Input consists of MSB-first DAC signals to 1DAC, and can be connected to the step level of 96 or 98 steps per 1DAC cycle or up the level of four-times oversampling data.

YM3815-H	Q OUT output
YM3613C	DO output
YM3623B	DO output
YM3404B	DLO output (1DAC output)

Connection is also possible with signals that allow connection with the DAC of other manufacturers.

- Output can be directly connected to PCM56 of Burr-Brown
- Its minimum levels −8 dB and log-linear characteristics are porvided for 300 steps in 0.2 dB units over a range from −65.8 dB (the minimum level preceding the first step) to 0 dB.

■ ELECTRICAL CHARACTERISTICS

1 Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit
Supply voltage	V_D	−0.3	7.0	V
Input voltage	Vi	V_{SS}−0.3	V_{DD}+0.5	V
Operating Temperature	Top	0	+70	℃
Storage temperature	Tstg	−50	+125	℃

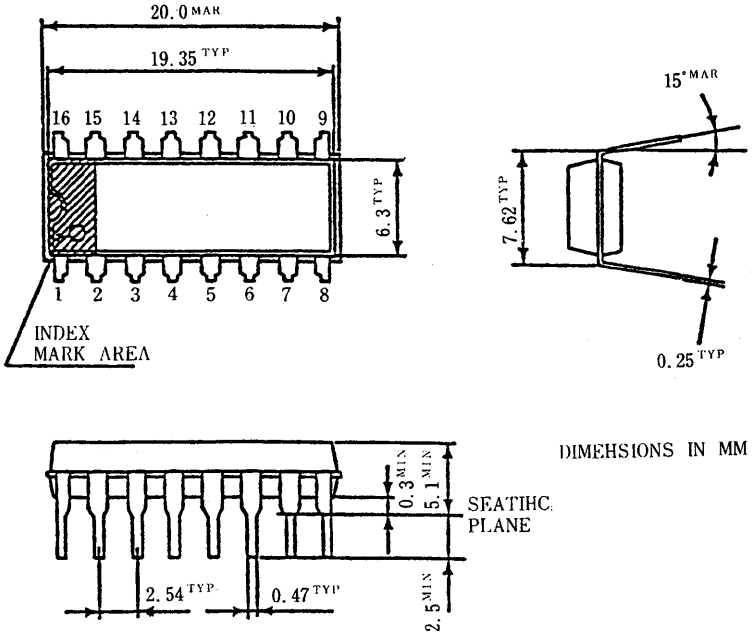
2 Recommended Operating Conditions

Item	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_{DD}	4.75	5.00	5.25	V
Operating temperature	Top	0	25	70	℃

3 Electrical Characteristics

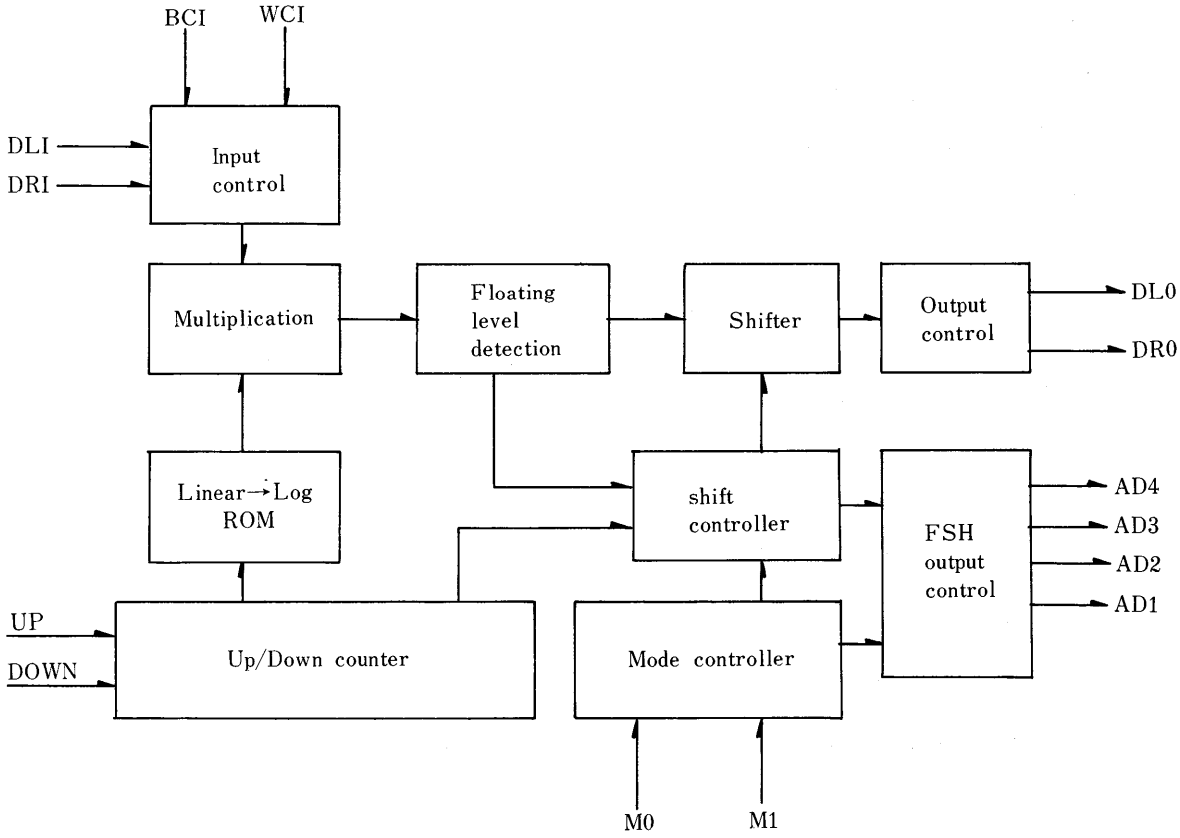
Item	Symbol	Terms	Min.	Typ.	Max.	Unit
Clock frequency	fc	(BCI input)			9.216	MHz
Low-level input voltage	VIL		0		0.4	V
High-level input voltage	VIH	(Excluding M0,M1)	2.4		V_{DD}	V
Hight-level input voltage	VIH	M0,M1	4.0		V_{DD}	V
Low-level output voltage	VOL		0		0.4	V
High-level output voltage	VOH		2.4		V_{DD}	V
DATA set-up time	Tset	(DLI SRI WCI)	50			nSec
DATA hold time	THLD	(DLI DRI WCI)	15			NSec
Clock ON time	TCLH	(BCI)	40			nSec
Clock OFF time	TCLL	(BCI)	40			nSec
Output delay time		(DLO, DRO)	0	45	45	nSec
Output delay time		AD4, AD1)		100	100	nSec
Output capacity				50	50	PF
UP/DOWN terminal ON time			BCI × 2 clocks			—
UP/DOWN terminal OFF time			BCI × 2 clocks			—

■ OUTLINE DIMENSIONS



DIMEHSIONS IN MM

■ BLOCK DIAGRAM



DIGITAL AUDIO

Compact Disc Player Servo Linear Circuit

XC488A0 SLC-B II

■ DESCRIPTION

The XC488A0, an IC developed for use in compact-disc players, comprises in itself practically all of pickup servo circuits in the CD player. For the pickup, it has a 3-spot optical sensor. Built in this IC are: HF amplifier, focus tracking servo, and drive amplifiers for focus, disc, feed and tracking. Complete with focus balance adjusting terminal.

■ FEATURES

- Small power consumption by operation with +5 volt power.
- Single chip implementation of practically all pickup servos by its 42-pin SDIP configuration. Powerful tool of reducing the number of parts and the device size, of cutting down the cost and of rising reliability.
- Applicable not only to CD players but also to CD-ROM and to the servo systems of other optical discs.

BUILT-IN FUNCTIONS

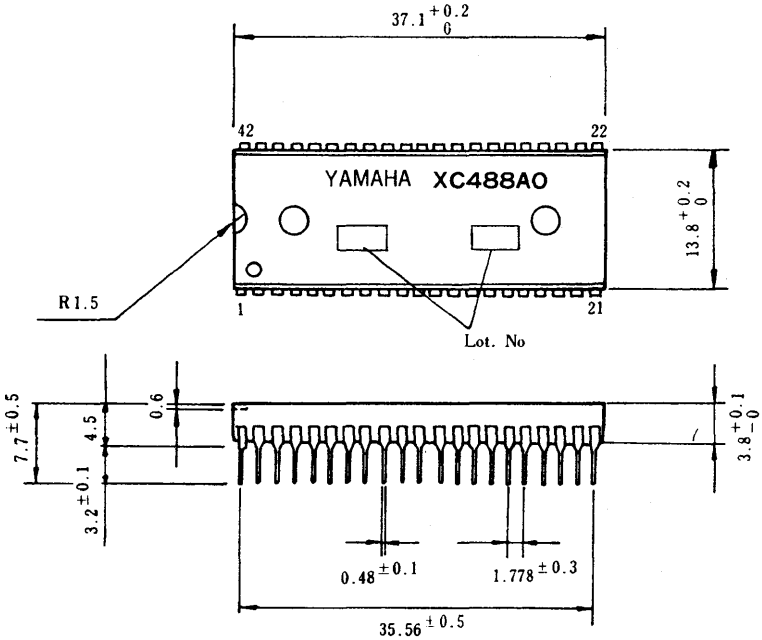
- HF (sensor output) amplifier
- Focus-error and output-drive amplifiers
- Focus search circuit
- Focus ON sensing circuit
- Tracking-error and output-drive amplifiers
- Track jump control circuit
- Track-zero cross comparator
- Off-track comparator (HF det.)
- Tracking drive limiter circuit
- Feed servo drive amplifier
- Disc servo drive amplifier

■ Electrical Characteristics

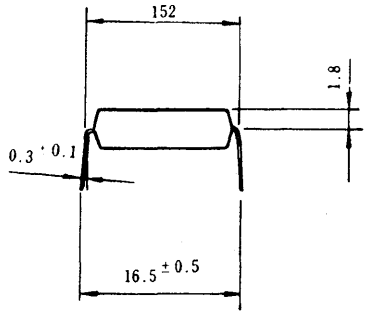
(Unless otherwise specified, these specifications apply for Ta=25°C.
V_{CC}/V_{EE} = ±5V input signals are sine waves, Frequency is 1kHz.)

Parameter	Symbol	Limits			Unit	Condition	Input	Measurement	Comment No.
		Min	Typ	Max					
Supply current	I_{CC}	–	11	17	mA		–	I_1	–
Supply current	I_{EE}	–	12	18	mA		–	I_2	–
HF amp output voltage	V_{HF}	0.7	1.3	2.2	Vp-p	f=2MHz,sine,V_{IN}=10mVp-p	e_3	U_4	–
Focus offset voltage	V_{FEO}	−0.5	2.3	4.3	V		–	V_{10}	–
Tracking offset voltage	V_{TEO}	−0.49	−0.09	0.19	V		–	V_1	–
FRF comp threshold voltage	VthF	0.25	0.38	0.51	V	V_4 Voltage as V_5=Hi	E_3	V_4	①
FZC comp threshold voltage	T_{HD}	0.33	0.39	0.51	–	F=1kHz,sine wave,Vin=10nVp-p V_4 voltage as V_5=Hi	E_3	U_4, V_4	②
FZC comp threshold voltage	VthC	−0.25	−0.15	−0.09	V	V_7 voltage as V_8=Hi	E_3	V_7	③
TER comp threshold voltage	ATThR	−0.45	−0.10	0.25	V	Adjusting E_2 V_3 voltage as V_2=Low	E_2	V_3	④
Focus off attenuation ratio	ATT_{FOF}	24	33	–	dB	V_{IN}=10mVp-p E_4=0V→5V	e_3	U_5	⑤
Tracking sw attenuation ratio 1	ATT_{TOF1}	39	53	–	dB	V_{IN}=10mVp-p At 10_{pin} 0V-5V (SW2)	e_2	U_3	⑥
Tracking sw attenuation ratio 2	ATT_{TOF2}	2.2	4.5	6.9	dB	V_{IN}=10mVp-p 10PIN 0V→5V (SW3)	e_2	U_3	⑦
Tracking sw attenuation ratio 3	ATT_{TOF3}	22	28	35	dB	V_{IN}=10mVp-p 9PIN 0V→5V(SW2)	e_2	U_3	⑧
Tracking sw attenuation ratio 4	ATT_{TOF4}	42	53	–	dB	V_{IN}=10mVp-p E_1=0V→±1V	e_2	U_3	⑨
DM amp output voltage	V_D	0.85	1.00	1.15	Vrms	V_{IN}=1Vrms	e_4	U_7	–
FEM amp output voltage	V_{FE}	0.85	1.00	1.15	Vrms	V_{IN}=1Vrms	e_1	U_1	–
Focus seach voltage	V_{FS}	−1.11	−0.85	−0.59	V	E_4=5V	E_4	V_{10}	–
Focus output voltage	V_{FDO}	0.5	0.85	1.10	Vrms	V_{IN}=0.5mVrms	e_3	U_6	–
Tracking output voltage	V_{FDO}	1.16	1.65	2.15	Vp-p	V_{IN}=5mVp-p	e_2	U_2	–
Focus seach offset voltage	V_{FSO}	−40	0	40	mV	E_4=5V external resistance=2kΩ	E_4	V_{10}	–
Tracking pre slew rate R	T_{PS}	0.15	–	–	V/us	Input:Pulse wave V_{IN}=±3Vp-p Rg=50Ω, f=1kHz, fall slew rate	e_5	T_1	⑫
Tracking drever slew rate	T_{DS}	0.15	–	–	V/us	Input:Pulse wave V_{IN}=±3p-p Rg=50Ω, f=1kHz, fall slew rate	e_6	T_2	⑪

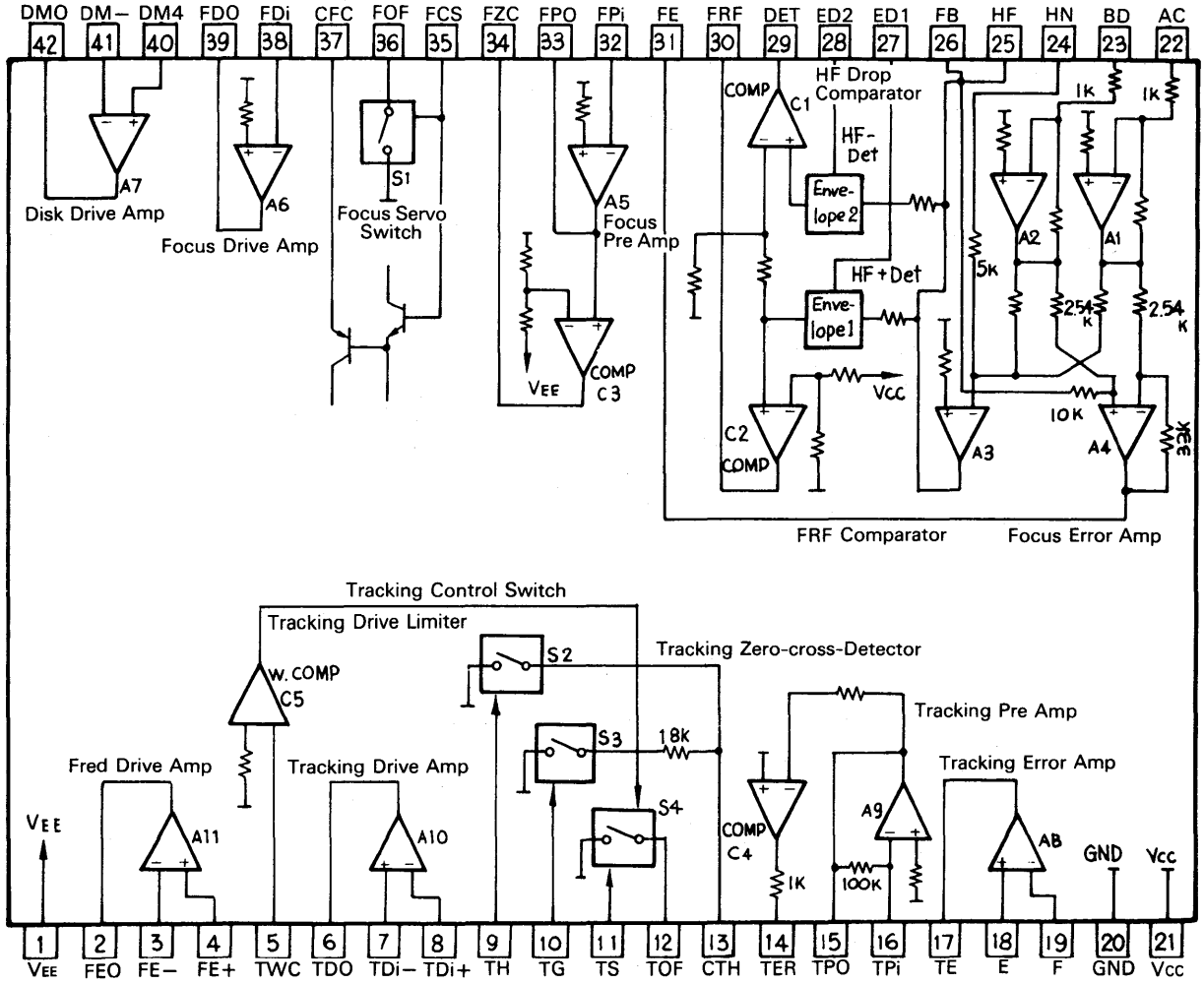
■ OUTLINE DIMENSIONS



Surface of terminal: Solder plated
Material of terminal: 42 Ni



■ BLOCK DIAGRAM



DIGITAL AUDIO

Pre-servo amplifier

XD777AO

■ FEATURES

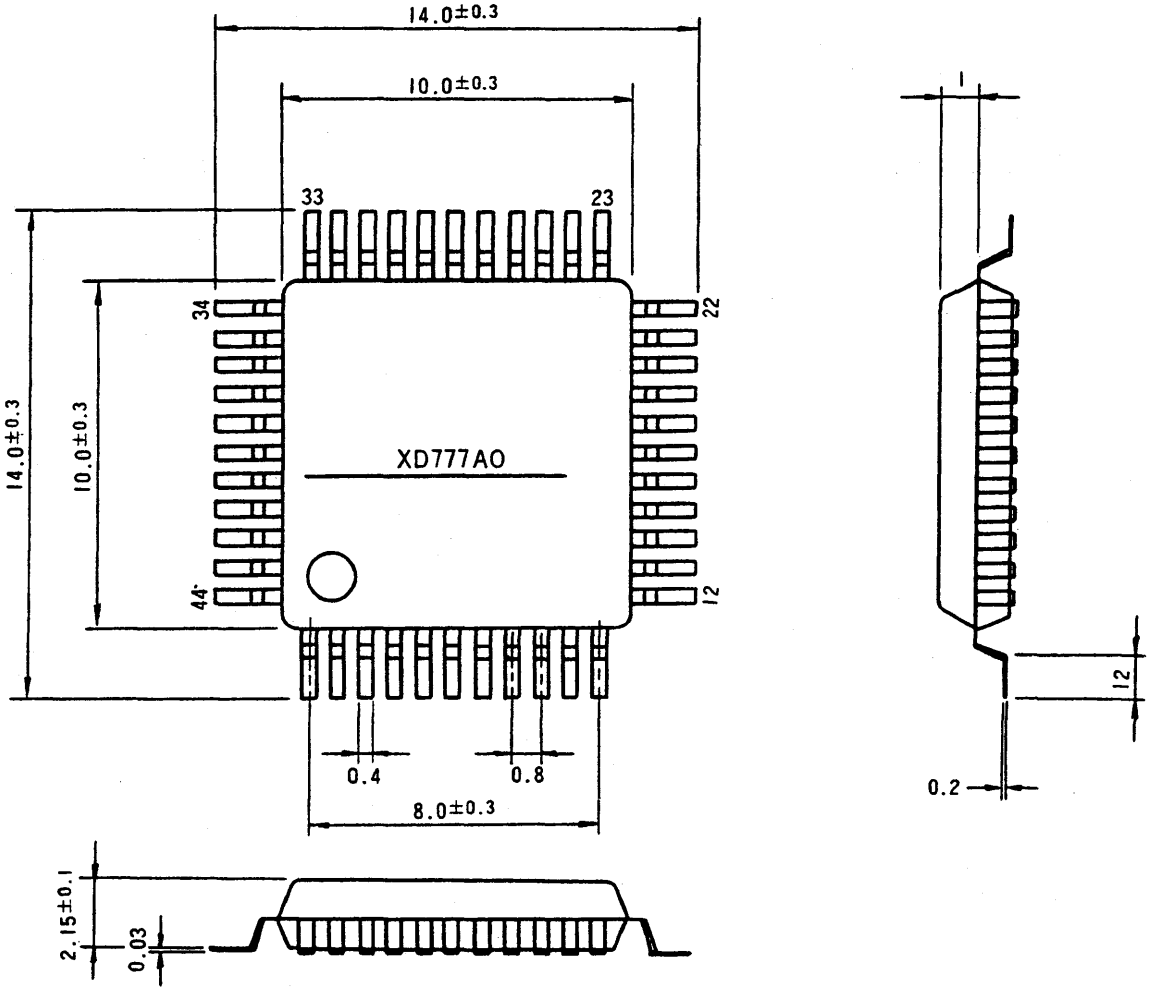
- +5V single power supply version. Low power consumption (55mW)
- For both focus and tracking servo, both balance and offset are adjustable.
- The threshold voltage for both FRF and HFD comparators are changeable.
- Variable loop gain switch for track jump is included.
- By connecting external shock sensor, trackability is improved.

■ ELECTRICAL CHARACTERISTICS

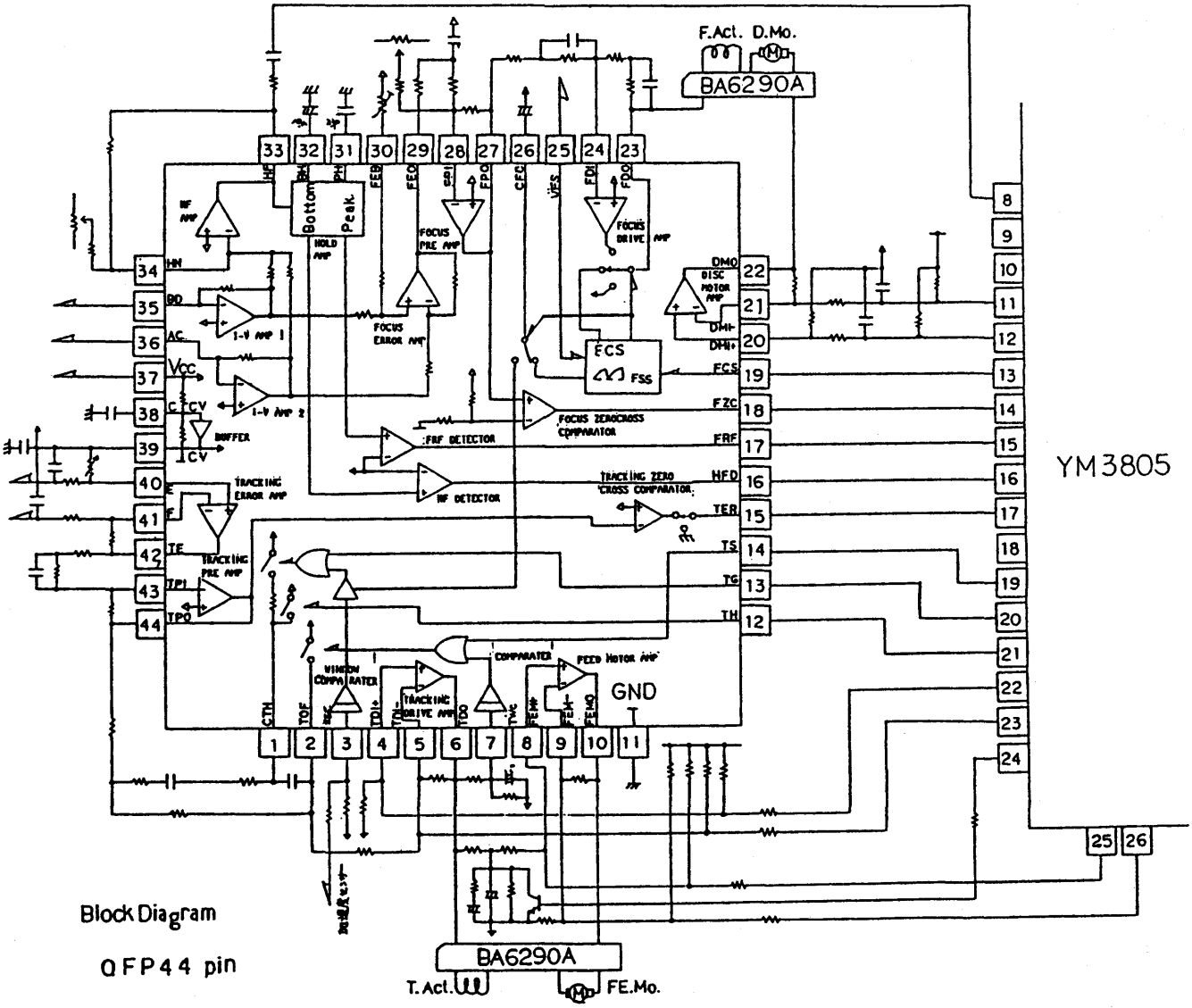
Absolute Maximum Ratings (Ta=25℃)

	Symbol	Limits	Unit
Source voltage	V_{CC}	6.0	V
Power dissipation	Pd	400	mW
Operating temperature	Topr	−25～+75	℃
Storage temperature	Tstg	−55～+125	℃

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



D/A CONVERTER

2-Channel Serial & Binary input Floating D/A Converter

YM3015 DAC(CD)

■ OUTLINE

The YM3015 : DAC-GS is a floating D/A converter (referred to as DAC hereafter) with the 2-channel serial and 16-bit binary input or 2's complement input. It can produce analog output (16-bit dynamic range) which has 10-bit mantissa and 7-step exponent characteristic for the input digital signal.

■ FEATURES

- 16-bit input format can select either binary or 2's complement (equipped with a built-in floating converter logic).
- Externally equipped with buffer operational amplifier it allows easy analog output.
- 16-bit wide dynamic range.
- Capable of processing PCM sound source up to 2 channels.
- Equipped with a built-in analog switch for sample hold.
- Lower noise and less harmonic distortion and outstanding temperature characteristics.
- Made by the monolithic process of highly accurate thin film resistor and CMOS and enclosed in the 16-pin plastic flat package.

■ ELECTRICAL CHARACTERISTICS

① Absolute Maximum Ratings

Item	Rating	Unit
Supply voltage	−0.3 ~ +15.0	V
High-level input voltage	V_{DD} +0.3	V
Low-level input voltage	V_{SS} −0.3	V
Operating ambient temperature	0~70	°C
Storing temperature	−50~+125	°C

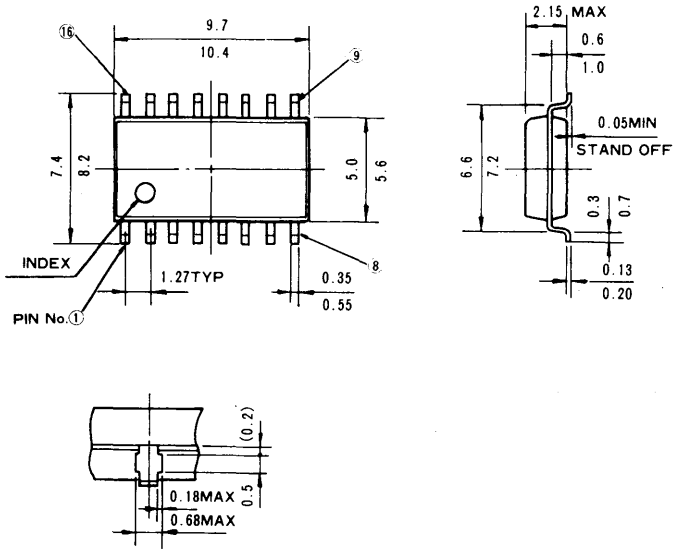
② Recommended Operating Conditions

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{DD}	9.0	12.0	12.0	V
	V_{SS}	0	0	0	V
Input signal voltage	CLOCK SD SMP1, 2 $\overline{ICL}$	0	—	V_{DD}	V
Operating ambient temperature	Ta	0	—	70	°C

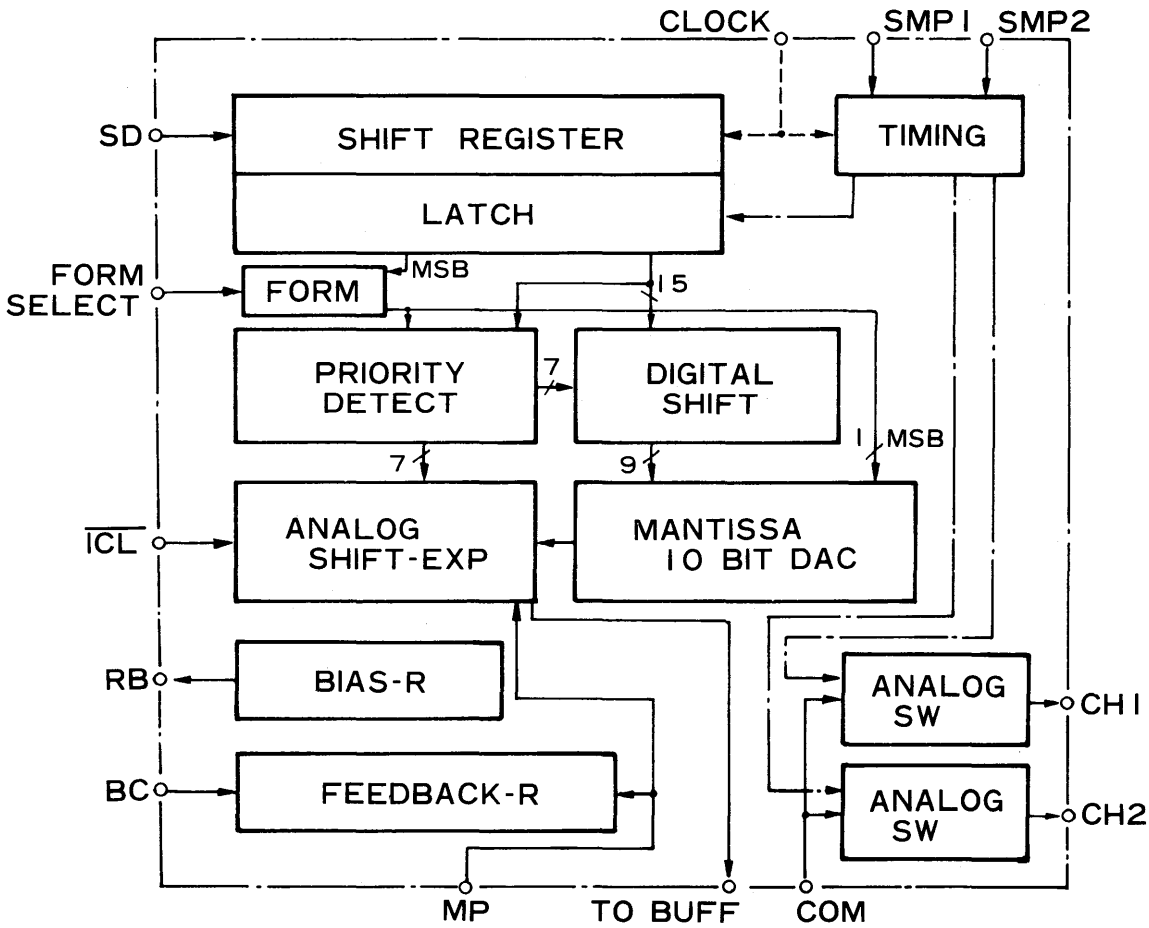
③ DC Characteristics

Item	Symbol	Measuring Conditions	Min	Typ	Max	Unit
High-level input voltage	V_{IH}	$V_{DD} \geqq 9.0V$	1/3 V_{DD}	—	—	V
Low-level input voltage	V_{IL}	$V_{DD} \geqq 9.0V$	—	—	1.0	V
Input current	I_{IN}	V_{DD} = 12.0V	—	—	10^{-3}	μA
Analog output voltage	V_{OUT}		—	0.50V_{DD}	—	Vp−p
Supply current	I_{DD}	V_{DD} = 12.0V	—	—	6	mA

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



D/A CONVERTER

2-Channel Serial & Binary input Floating D/A Converter

YM3016 DAC(CD)

■ OUTLINE

The YM3016 : DAC-GS is a Floating D/A converter (referred to as DAC hereafter) with the 2-channel serial and 16-bit binary input or 2's complement input. It can produce analog output (16-bit dynamic range) which has 10-bit mantissa and 7-step exponent characteristic for the input digital signal.

■ FEATURES

- 16-bit input format can select either binary or 2's complement (due to built-in floating converter logic).
- Analog output can be obtained easily by adding a buffer operational amplifier, etc.
- 16-bit wide dynamic range.
- Capable of processing PCM sound source up to 2 channels.
- Equipped with a built-in analog switch for sample hold.
- Lower noise and less harmonic distortion and outstanding temperature characteristics.
- Made by the monolithic process of highly accurate thin film resistor and CMOS.
- Package type: 16 pin plastic SOP : YM3016F
  DIP : YM3016D
- +5V single power supply.

■ Electrical characteristics

① Absolute Maximum Ratings

Item	Rating	Unit
Supply voltage	−0.3 ~ +15.0	V
High-level input voltage	V_{DD} +0.3	V
Low-level input voltage	V_{SS} −0.3	V
Operating ambient temperature	0 ~ 70	°C
Storing temperature	−50 ~ +125	°C

② Recommended Operating Conditions

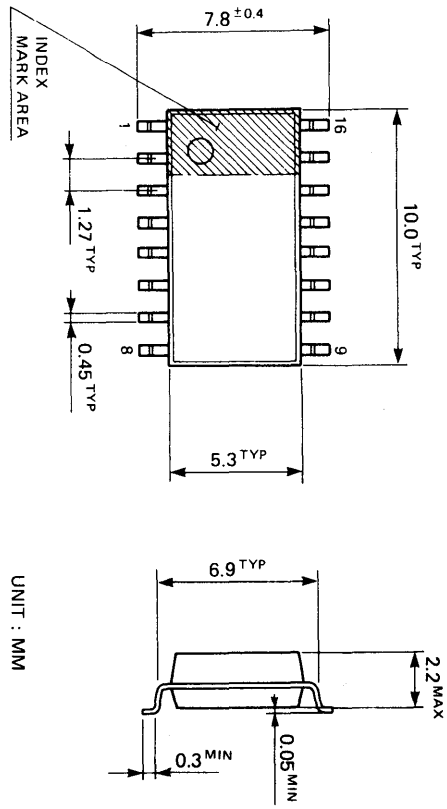
Item	Symbol	Min		Max	Unit
Supply voltage	V_{DD}	4.75*	5.0	5.25	V
	V_{SS}	0	0	0	V
Input signal voltage	CLOCK SD SMP1, 2 ICL	0	—	V_{DD}	V
Operating ambient temperature	Ta	0	—	70	°C

③ DC Characteristics

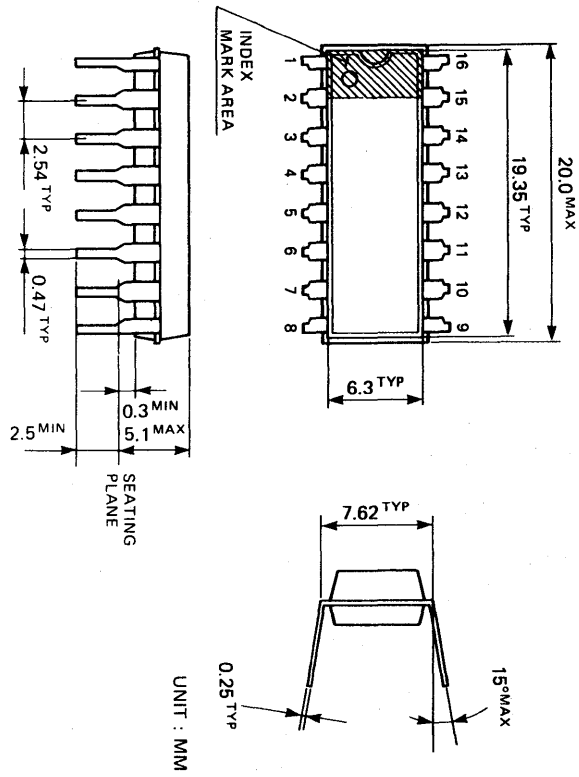
Item	Symbol	Measuring Conditions	Min	Typ	Max	Unit
High-level input voltage	V_{IH}		0.66V_{DD}	—	—	V
Low-level input voltage	V_{IL}		—	—	0.30V_{DD}	V
Input current	I_{IN}	V_{DD} = 5.0V	—	—	10^{-3}	μA
Analog output voltage	V_{OUT}		—	0.50V_{DD}	—	Vp−p
Supply current	I_{DD}	V_{DD} = 5.0V	—	—	6	mA

■ OUTLINE DIMENSIONS

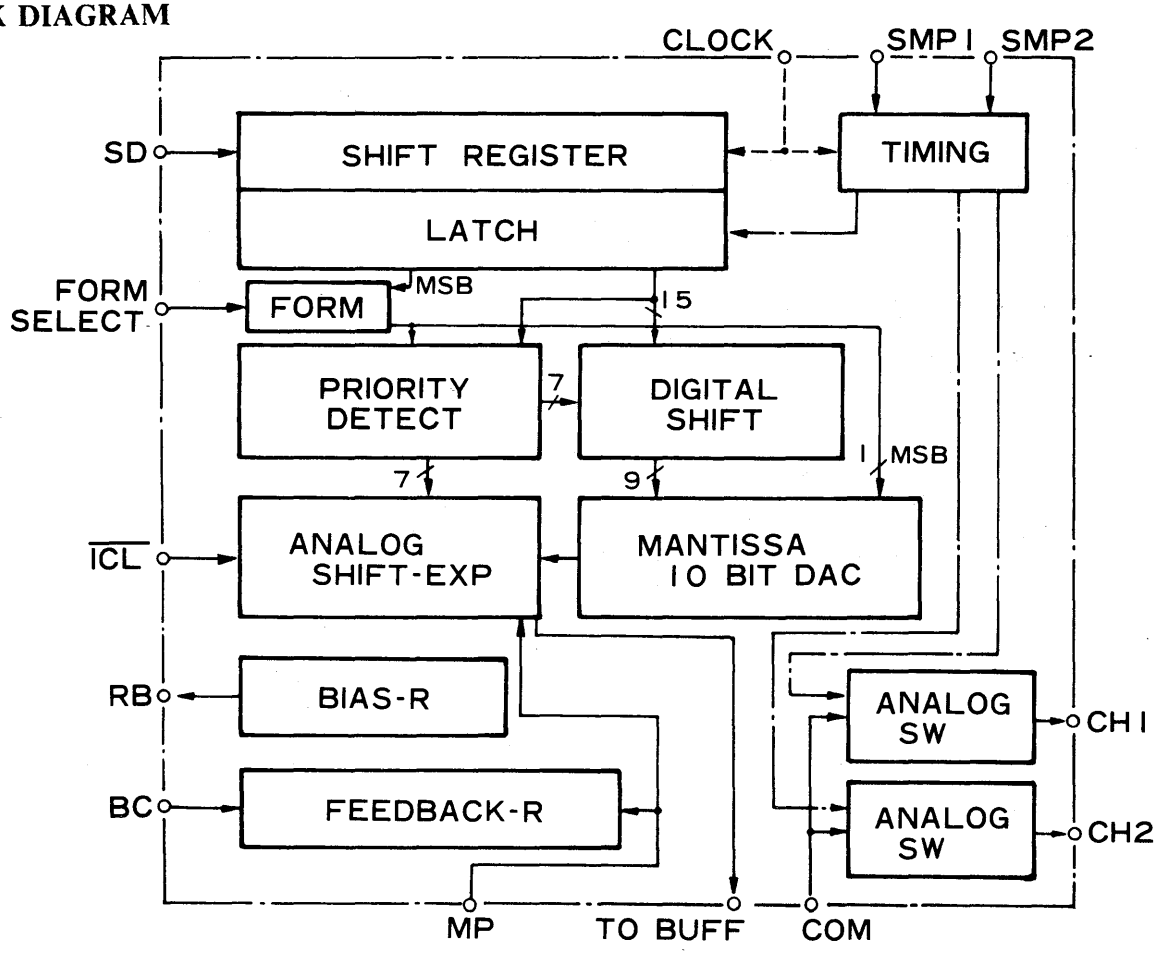
YM3016-F



YM3016-D



■ BLOCK DIAGRAM



D/A CONVERTER

2-Channel Serial & Binary input Floating D/A Converter

YM3020 DAC(CD)

■ OUTLINE

The YM 3020 : DAC-FS is a floating D/A converter (referred to as DAC hereafter) with the 2-channel serial and 16-bit binary input or 2's complement input. It can produce analog output (16-bit dynamic range) which has 13-bit mantissa and 7-step exponent characteristic for the input digital signal.

■ FEATURES

- 16-bit input format can select either binary or 2's complement (equipped with a built-in floating converter logic).
- Externally equipped with buffer operational amplifier it allows easy analog output.
- 16-bit wide dynamic range.
- Capable of processing PCM sound source up to 2 channels.
- Equipped with a built-in analog switch for sample hold.
- Lower noise and less harmonic distortion and outstanding temperature characteristics. Zero cross distortion is extremely little.
- Made by the monolithic process of highly accurate thin film resistance and CMOS and enclosed in the 16-pin plastic DIL package.

■ Electrical characteristics

1. Absolute Maximum Rating

Item	Rating	Unit
Supply voltage	−0.3 ~ +15.0	V
High-level input voltage	V_{DD} +0.3	V
Low-level input voltage	V_{SS} −0.3	V
Operating ambient temperature	0~70	°C
Storing temperature	−50~+125	°C

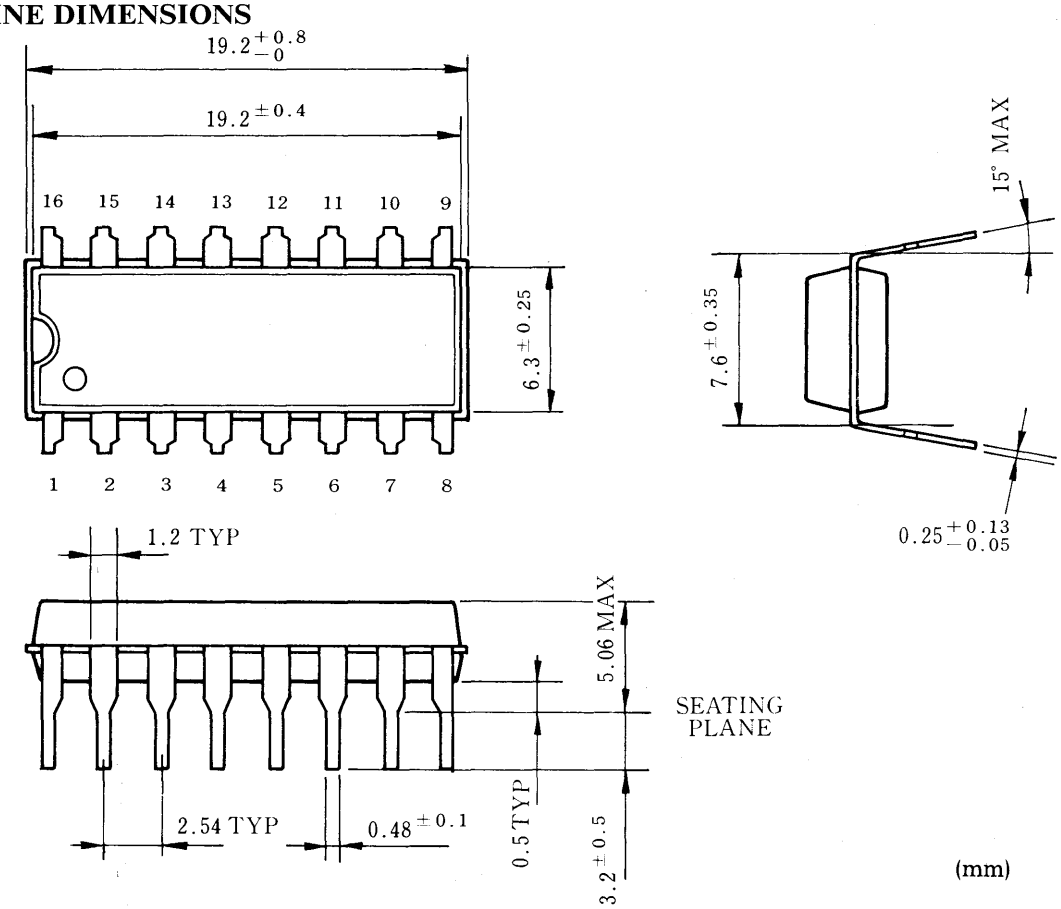
2. Recommended Operating Conditions

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{DD}	9.0	12.0	12.0	V
	V_{SS}	0	0	0	V
Input signal voltage	CLOCK SD SMP1, 2 $\overline{ICL}$	0	—	V_{DD}	V
Operating ambient temperature	Ta	0	—	70	°C

3. DC Characteristics

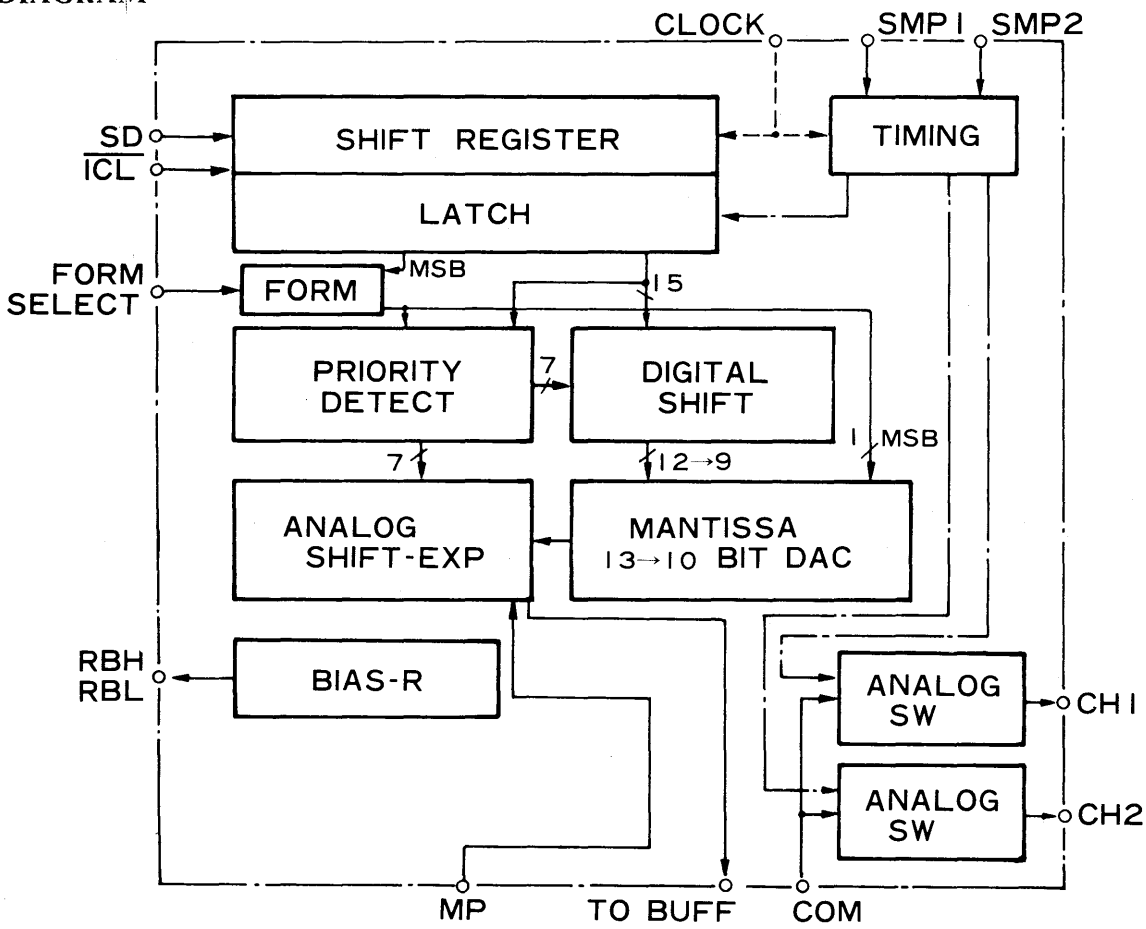
Item	Symbol	Measuring Conditions	Min	Typ	Max	Unit
High-level input voltage	V_{IH}	$V_{DD} \geqq 9.0V$	1/3 V_{DD}	—	—	V
Low-level input voltage	V_{IL}	$V_{DD} \geqq 9.0V$	—	—	1.0	V
Input current	I_{IN}	V_{DD} = 12.0V	—	—	10^{-3}	μA
Analog output voltage	V_{OUT}		—	0.50V_{DD}	—	Vp−p
Supply current	I_{DD}	V_{DD} = 12.0V	—	—	6	mA

■ OUTLINE DIMENSIONS



(mm)

■ BLOCK DIAGRAM



D/A CONVERTER

2-Channel 2's complement MSB 1st input Floating D/ A Converter

YM3025 DAC(CD)

■OUTLINE

The YM3025 is a floating D/A converter with the 2-channel serial and 16-bit 2's complement input. It can produce anglog output (16-bit dynamic range) which has 10-bit mantissa and 7-step exponent characteristic for the input digital signal.

■FEATURES

- 16-bit input format is 2's complement and MSB 1st (equipped with a built-in floating converter logic).
- Analog output can be easily obtained by connecting external buffer op-amp and other components.
- +5V single power supply including op-amp.
- Can be used in 1-channel operation.
- LRCK or SHL input is also available.
- 16-bit wide dynamic range.
- Capable of processing PCM sound source up to 2 channels.
- Equipped with a built-in analog switch for sample hold.
- Lower noise and less harmonic distortion and outstanding temperature characteristics.
- Made by the monolithic process of highly accurate thin film resistor and CMOS and enclosed in 16-pin plastic flat package.

■ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Item	Rated value	Units
Power supply voltage	-0.3～+15.0	V
High-level input voltage	V_{DD}+0.3	V
Low-level input voltage	V_{SS}-0.3	V
Operating ambient temperature	0～70	℃
Storing temperature	-50～+125	℃

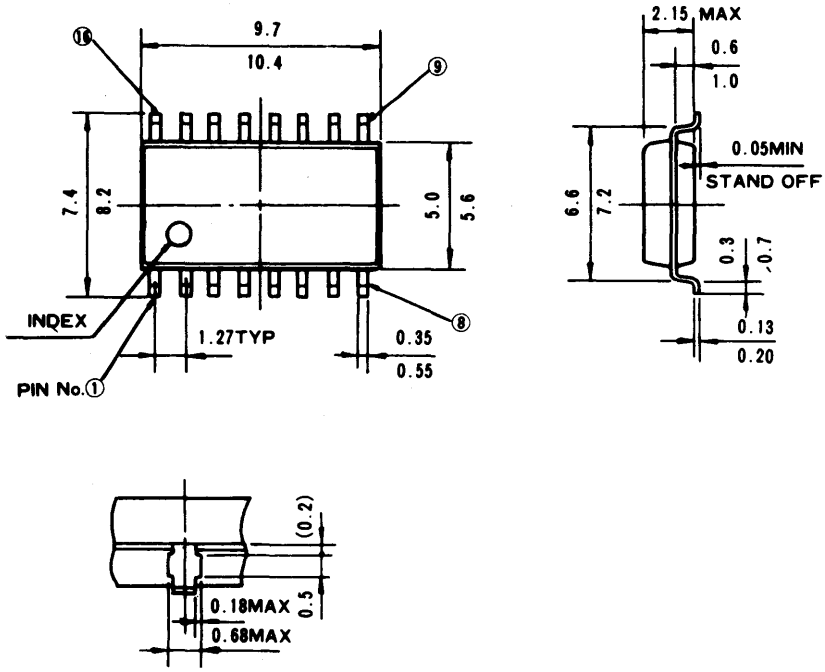
Recommented Operating Conditions

Item	Symbol	Min.	Typ.	Max.	Units
Power supply voltage	V_{DD}	4.75	5.0	5.25	V
	V_{SS}	0	0	0	V
Input signal voltage	CLOCK, SD, SMP1, 2, $\overline{ICL}$	0	–	V_{DD}	V
Operating ambient temperature	Ta	0	–	70	℃

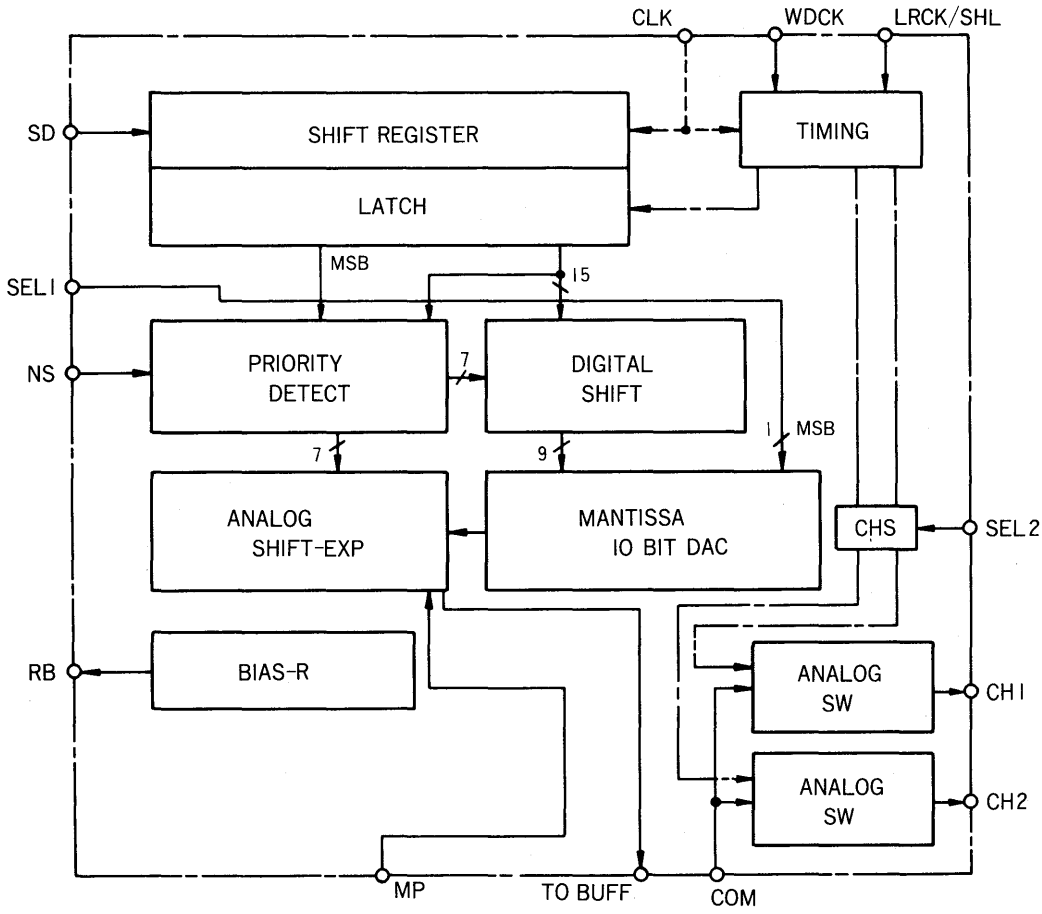
Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Units
High-level input voltage	V_{IH}		3.3	–	–	V
Low-level input voltage	V_{IL}		–	–	1.0	V
Input current	I_{IN}	V_{DD}=5.0V	–	–	1	μA
Analogue output voltage	V_{OUT}		–	$\frac{1}{3}V_{DD}$		Vp−p
Supply current	I_{DD}	V_{DD}=5.0V	–	–	6	mA

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



D/A CONVERTER

18 bits Trimming D/A Converter

YM4113B3 DAC(CD)

■OUTLINE

A digital audio 18 bit DA converter, the YM4113B3 provides a high degree of precision by trimming of the NiCrSi thin film resistance network.

The high speed current output from the bipolar D/A converter is converted to voltage output by the operational amplifier integrated into the chip. This makes it possible for both current output and voltage output modes to be used.

MSB errors can be compensated for by making external adjustments, permitting the highest possible degree of accuracy.

■FEATURES

- 18 bit discrimination
- 2's complement, MSB first input
- Rate of harmonic distortion 0dB, 1KHz MAX 0.008%
  −20dB, 1KHz MAX 0.06%
- Highly reliable 16 pin plastic DIP
- 8 times oversampling compatibility (2DAC)

■ELECTRICAL CHARACTERISTICS

Adsolute Maximum Ratings

Item		Rating	Unit
DC supply voltage	$\pm V_A$	±11.0	V
	$\pm V_D$	±7.0	V
Operating temperature		−25～+70	℃
Storage temperature		−60～+100	℃

Recommended Operating Conditions

Item		Min	Typ	Max	Unit
Supply voltage	$+V_A$	+4.75	+5.0	+10.0	V
	$-V_A$	−10.0	−5.0	−4.75	V
	$+V_D$	+4.75	+5.0	+6.0	V
	$-V_D$	−6.0	−5.0	−4.75	V
Digital input	V_{IH}	+2.4	−.	$+V_D$	V
	V_{IL}	0	−	0.8	V
Input clock frequency				10.0	MHz
Ambient operating temperature		0	−	+70	℃

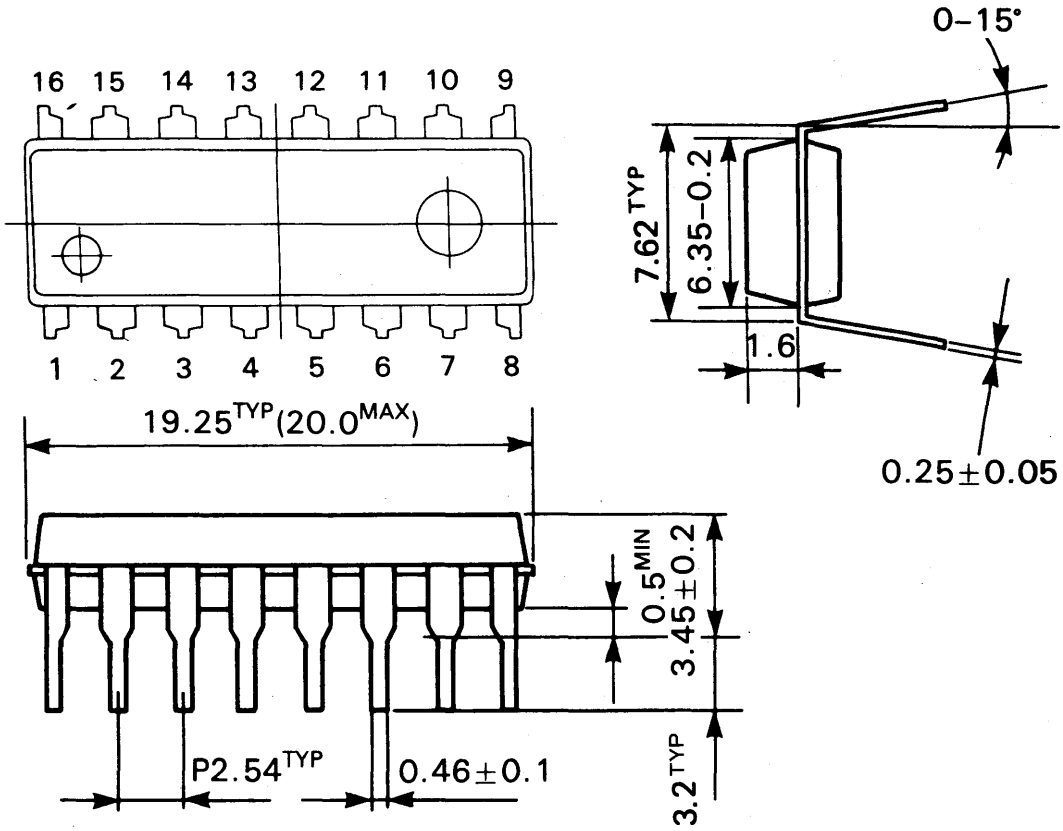
NOTE: $|-V_D| \leqq |-V_A|$

DAC Features

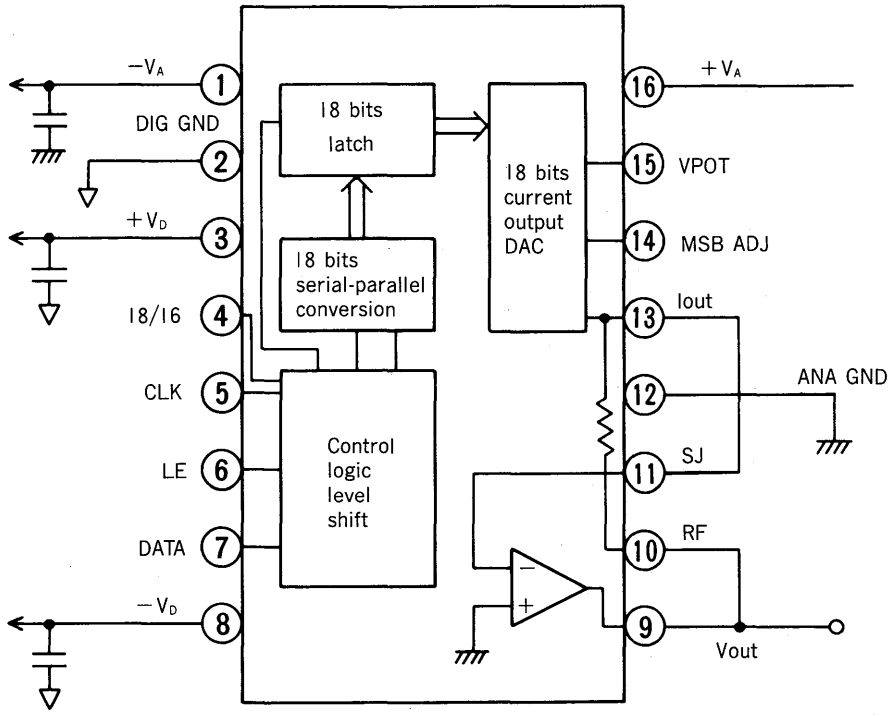
Item	Min	Typ	Max	Unit
Discrimination		18		Bits
Total Harmonic Distortion *1				
0dB, 1KHz		0.004	0.008	%
−20dB, 1KHz		0.04	0.06	%
−60dB, 1KHz		2.0	4.0	%
S/N		110		dB
Bipolar zero error		±30		mV
Voltage output connection: Bipolar range		±3.0		V
Current output		±2.0		mA
Current output connection: Bipolar range		±1.0		mA
Warm-up time	1			Min

*1 Ta=25℃, $\pm V_A = \pm V_D = \pm 5V$, CLK=8.62MHz

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



GRAPHICS

LCD & CRT Display Controller

V6355D-H LCDC

■ OUTLINE

V6355D (LCDC) is a silicon gate CMOS device. This controller can be connected to both LCD and CRT displays. It is software compatible with IBM-PC and has a function to expand it.

■ FEATURES

- Capable of controlling both LCD and CRT displays.
- Includes 6845 restricted mode and CRT peripheral circuits for IBM-PC.
- Both SRAM and DRAM are usable as VRAM.
- Includes MOUSE and LIGHT PEN interface.
- Cursor position can be specified by any 16 × 16 dot patterns in the bit unit (AND and EXOR screens).
- Includes color palette (16/512 colors).
- LCD intensity controllable (16 or 8 gradation steps)
- Screen modes are available in combinations of the following.
  Horizontal dot number: 640, 320, 512, 256
  Vertical dot number: 192, 200, 204, 64 (64 only with LCD)
  Raster adjustment: 0, 2, 4 or 6 specifiable
- Capable of displaying 16 colors in 640 × 204 by using external circuits.
- CRT monitor selectable from among IBM Color, Monochrome, NTSC system and PAL system.
- Can be interfaced with 3 types of LCD driver.
- Usable with 16 bit bus CPU.
- CMOS 100-pin QFP

■ ELECTRICAL CHARACTERISTICS

① **Absolute Maximum Ratings**

Item	Symbol	Min.	Max.	Unit
Supply voltage	V_{DD}	−0.5	+7.0	V
Input voltage	V_I	−0.5	V_{DD}+0.5	V
Output voltage	V_O	−0.5	V_{DD}+0.5	V
Operating temperature	T_{OP}	0	+70	°C
Storage temperature	T_{STG}	−50	+125	°C

(Vss, AVss=0.0V as standard)

② **Recommended Operating Conditions**

Item	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_{DD}	4.75	5.0	5.25	V
Operating temperature	T_{OP}	0	25	70	°C

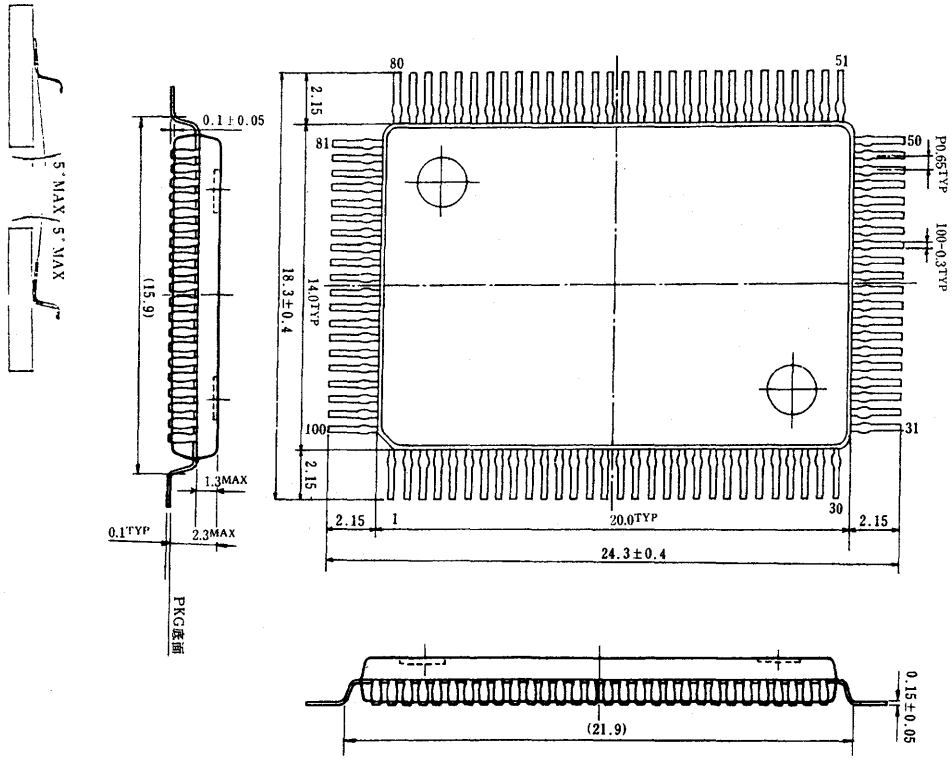
Used with V_{DD} and AV_{DD} at the same voltage and Vss, AVss=0.0V.

③ **DC Characteristic**

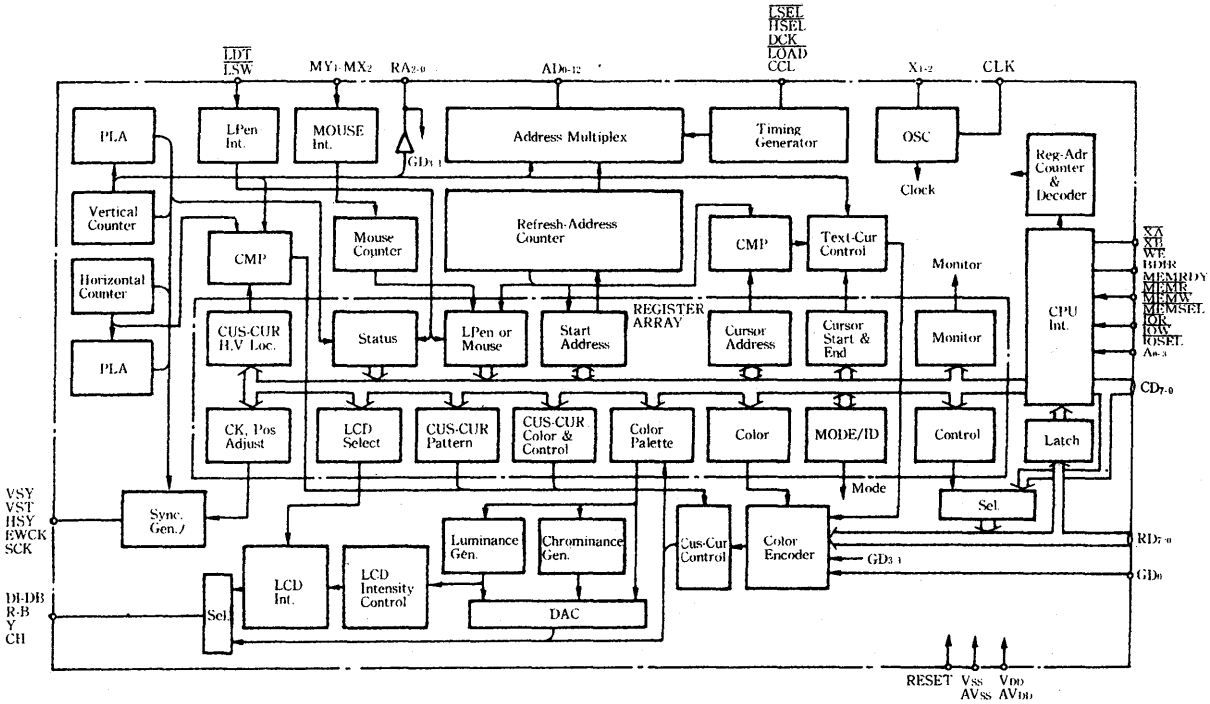
Item	Symbol	Conditions	Min.	Max.	Unit
High-level output voltage (TTL)	V_{OH}	I_{OH}= −0.4mA	2.7		V
Low-level output voltage (TTL)	V_{OL}	I_{OL}=0.8mA		0.4	V
High-level output voltage (CMOS)	V_{OH}	I_{OH} <1μA	V_{DD}−0.4		V
Low-level output voltage (CMOS)	V_{OL}	I_{OL} <1μA		0.4	V
High-level input voltage	V_{IH}		2.2		V
Low-level input voltage	V_{IL}			0.8	V
High-level output current	I_{OH}	V_{OH}=2.7V	−0.4		mA
Low-level output current	I_{OL}	V_{OL}=0.4V	0.8		mA
Input leak current	I_L		−10	10	μA
Output leak current (tri-state)	I_{LZ}		−10	10	μA
Supply current (at normal operation)	I_{DD}	R_L=5.6KΩ		70	mA
Supply current (at standby)	I_{DD}	R_L=5.6KΩ		50	mA
High-level clock input voltage	V_{CH}		3.6		V
Low-level clock input voltage	V_{CL}			0.6	V

- V_{DD}, AV_{DD}=5.0V ± 5%, T_{OP}=0 ~ 70°C
  Supply voltage is obtained by adding mean current at V_{DD} and AV_{DD} terminals.
- R_L: Terminal resistance between Y, R, G, B, CH terminals and GND.
  Output leak current (tri-state) is for when $CD_{0\sim7}$, $RD_{0\sim7}$ and $RA_2/GD_3 \sim RA_0/GD_1$ are in the input mode and when $AD_0 \sim AD_{12}/\overline{CAS}$, $\overline{LSEL}$, $\overline{HSEL}$ and MEMRDY are in the high impedance mode.

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



GRAPHICS

Panel Display & CRT Display Controller

V6366C-F PCDC

■ OUTLINE

The PCDC (Panel Display & CRT Display Controller) is a display controller that has the two functions: (1) the display control of a high-capacity flat-panel display (hereafter referred to as a "Panel") and (2) the display control of a raster-scan type CRT. By merely performing initialization, however, even the Panel can be used without changing the software for conventional CRTs, enabling the simple system configuration of a handheld or portable computer which uses the Panel. (If so required, the PCDC can also be used to switch the display monitor between a CRT and a Panel.)

The PCDC is compatible with the CGA (Color Graphics Adapter), MDA (Monochrome Display Adapter), and HGC (Hercules Graphics Card), all for IBM PC application. In case the software and hardware for connecting a regular monitor come as a pair, the PCDC offers compatibility without requiring software changes (initialization is also unnecessary). Even in case of connecting different monitors, initialization will only be performed once at Power Start-Up, then compatibility will be available without requiring any software changes. It is thus possible, for example, to run CGA software using an IBM monochrome monitor and the Panel. (A gray scaling/hatching display can be used with a monochrome monitor.)

Because the PCDC has the display capacity of the IBM PC as well as numerous other expansion functions, including Kanji display, Color Palette, and the capability to simultaneously display up to 256 colors, a high-performance display system can be easily configured.

■ FEATURES

- All functions of MC6845 are built in (excluding the Interlacing & Video Mode and the Skew function).
- In addition to a CRT or LCD, an EL and Plasma Display can also be connected.
- A 640 by 400 PEL Panel can be driven (a 720 by 350 PEL Panel can also be driven).
- A one-screen Panel or two-screen Panel (split into upper and lower halves) can be used.
- A two-screen panel allows, at a maximum duty, display of up to 512 lines (1/256).
- Selection of 1-, 2-, 4- or 8-bit parallel transmission of data to the Panel.
- A gray scaling/hatching display can be used with the Panel or a monochrome monitor.
- IBM PC software for 640 by 200 PELs can be directly displayed on a 640 by 400 PEL screen. (An 8 by 16 character font can be used, and can be displayed even in Double Scan Mode.)
- In addition to the standard IBM PC Graphics Modes, a variety of other Graphics Modes are provided: 320 by 200 PELs ×16 or 256 colors, 320 by 400 PELs ×4 or 16 colors, 640 by 200 PELs × 4 or 16 colors 640 by 400 PELs × 4 colors, 640 by 350 PELs × 16 colors, and so on.
- A Protect Bit is provided for software protection.
- An SRAM or DRAM can be used as the VRAM. (Because the timing for display and the CPU are separate, the CPU can access VRAM at any time (without awaiting the retrace-timing.))
- Built-in interface for the Light Pen
- With a linear RGB monitor, 16 out of 512 colors can be simultaneously displayed.
- With an EGA monitor, 16 out of 64 colors can be simultaneously displayed.
- A Color Lookup Table can even be used with an IBM color monitor.
- A Standby function is provided to conserve power dissipation.
- Kanji display capacity of 16 by 16, 24 by 24 or 32 by 32 "PELs" (picture elements or pixels). (Attributes can also be used).
- The font configuration can be selected. Horizontal: 6, 7, 8, 9, 10, or [8 × integer] PELs (capable of a mix display of half-width and full-width text); Vertical: 1 to 32 PELs.
- Capable of smooth scrolling and (in Interlace Mode only) external synchronization.
- Simultaneous display capability with an IBM color monitor and a one-screen LCD of 640 × 200.
- CMOS, 5V power supply, 100-pin QFP

■ ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit
Supply voltage	V_{DD}	−0.3	+7.0	V
Input voltage	V_I	−0.3	V_{DD}+0.3	V
Output voltage	V_O	−0.3	V_{DD}+0.3	V
Operating temperature	T_{OP}	0	+70	°C
Storage temperature	T_{STG}	−50	+125	°C

(Based on the reference voltage of V_{SS}=0.0V)

Recommended Operating Conditions

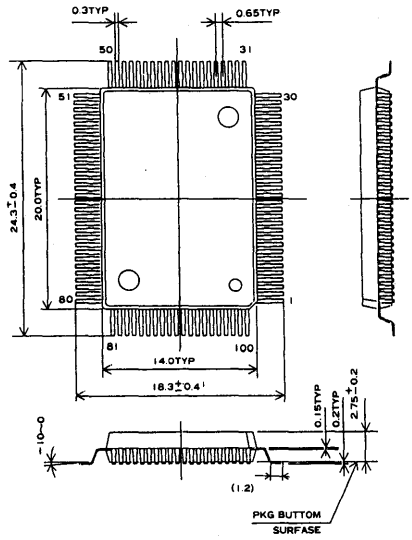
Supply voltage:	+5V±5% (based on V_{SS}=0.0V)
Operating temperature:	0~70°C

DC Characteristics (V_{DD}=5V±5%, T_{OP}=0~70°C)

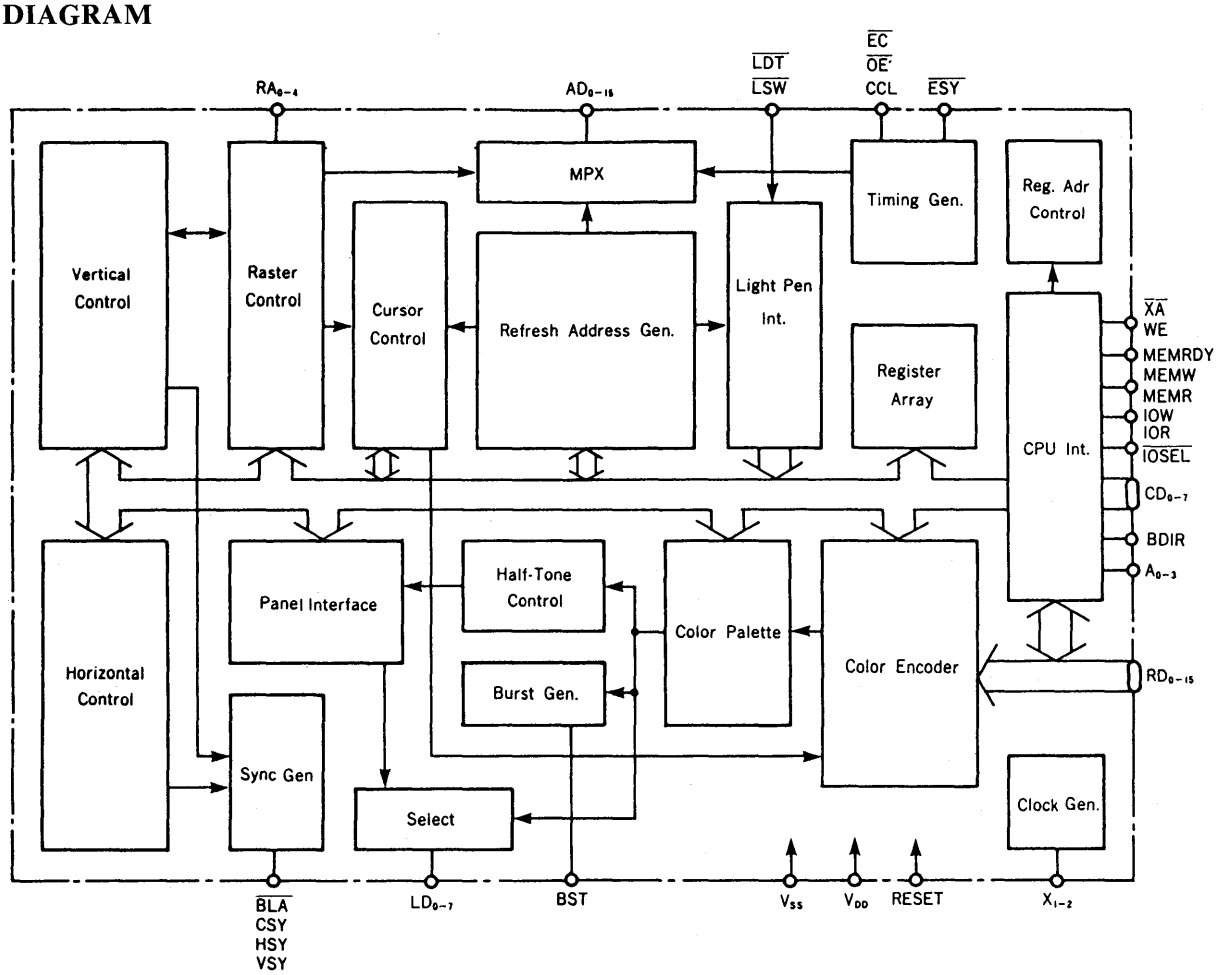
Item	Symbol	Condition	Min.	Max.	Unit
High-level output voltage (for TTL driving)	V_{OH}	I_{OH}=−0.4mA	2.7		V
Low-level output voltage (for TTL driving)	V_{OL}	I_{OL}=0.8mA		0.4	V
High-level output voltage (for CMOS driving)	V_{OH}	$\|I_{OH}\|$<10μA	V_{DD}−0.4		V
Low-level output voltage (for CMOS driving)	V_{OL}	$\|I_{OL}\|$<10μA		0.4	V
High-level input voltage	V_{IH}		2.2		V
Low-level input voltage	V_{IL}			0.8	V
Input leak current	I_L		−10	10	μA
OFF status leak current	I_{LZ}		−10	10	μA
Power current (during normal operation)	I_{DD}			70	mA
Power current (during Standby)	I_{DD}			10	mA

NOTE: ILZ applies while the CD0-CD7, RD0-RD15, X2, RA4, or $\overline{ESY}$ pins are in input status or while the AD0/$\overline{XR}$ ~ AD15/GPE or MEMRDY pins are in high-impedance status.

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



GRAPHICS

Enhanced Panel Display Controller

V6377 EPDC

■ OUTLINE

The enhanced panel display controller (EPDC) is a high-level display controller with functions for controlling large-capacity flat panel displays (hereinafter simply "panels") and for controlling raster-scanning CRT displays. In addition, since application software written for CRTs can be used as is when the EPDC BIOS is used, portable and transportable computers with panels can be configured easily. (Display switching between CRT and panel as necessary is possible.) This EPDC is completely compatible with the IBM-PC enhanced graphics adapter (EGA). When a standard monitor is used, this compatibility requires no change to the BIOS or software whatsoever. Even if a non-standard monitor is used, compatibility can be achieved by simply setting the values of switches with the EPDC BIOS. There is no need to change the software at all. For example when an IBM monochrome monitor and 2-tone panel are used, color display software can be executed. (Monitors that can not display colors handle this with gray scaling and hatching.)

In addition to EGA display capacity, the EPDC has expanded display functions, so it can also display 640 x 480 dots. It can also be easily configured for higher level display systems, with a built-in color look-up table (LUT) for color mapping.

■ FEATURES

- Since IBM EGA CRT-controller functions have been included, the EGA board function is realized with few parts. Furthermore, LCDs, plasma displays, and EL displays can be controlled as well.
- The EPDC can be connected to the following CRTs:
  - · IBM monochrome display
  - · IBM color display
  - · IBM enhanced color display
  - · NEC Multisync monitor (and models from other manufacturers that have the same functions)
- The EPDC can be connected to panels (LCD, plasma, EL) with the following resolutions:
  - · 640 x 200
  - · 320 x 200
  - · 640 x 400
  - · 640 x 480
- Eight 64K x 4 dynamic RAM chips or eight 32K x 8 static RAM chips can be used for video RAM (for a maximum of 256 KB)
- Up to 16 colors can be displayed for 640 x 480 dots.
- 1-screen panels and 2-screen panels can be used.
- The duty cycle can be set as high as 1/512 when a 2-screen panel is used.
- The AC signal for the LCD panel can be set freely in units of 1Horizontal scan (with a maximum pulse width of 1024H).
- Data can be sent to the panel in parallel 4 or 8 bits at a time or serially.
- Color liquid crystal displays can be used (320 x 200 dots by 8 colors)
- 16-shade display is possible with panels and monochrome monitors. (Of these 16, 9 can be converted into 9 hatching patterns.)
- Screen display position compensation is possible when using panels the same as for CRTs (Screen center can also be adjusted).

■ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings (with Vss = 0.0V as the standard)

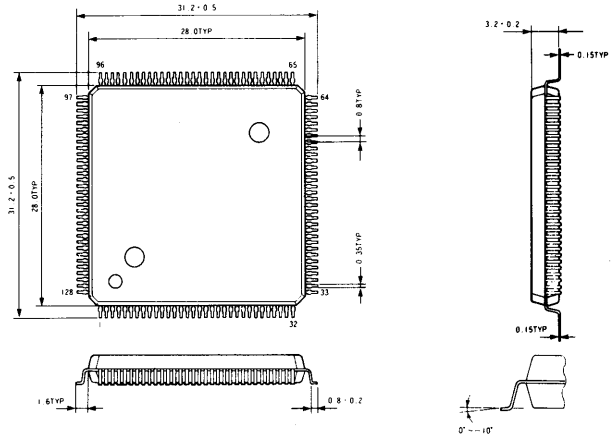
Item	Symbol	Min.	Max.	Unit
Power supply voltage	V_{DD}	-0.3	7.0	V
Input voltage	V_I	-0.3	V_{DD}+0.3	V
Output voltage	V_O	-0.2	V_{DD}+0.3	V
Operating ambient temperature	V_{OP}	0	70	℃
Storage temperature	T_{STG}	-50	125	℃

Recommended Operating Conditions (with Vss = 0.0V as the standard)

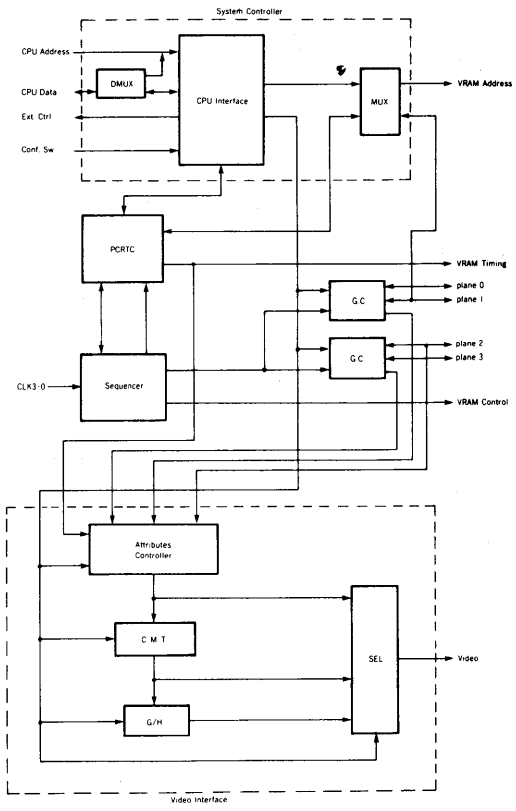
Item	Symbol	Min.	Typ.	Max.	Unit.
Power supply voltage	V_{DD}	4.75	5.00	5.25	V
Operating ambient temperature	T_{OP}	0	25	70	℃
Low level input voltage*	V_{IL}			0.8	V
High level input voltage*	V_{IH}	2.0			V

*: except for clock input

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



GRARHICS

Versatile Panel Display Controller

V6388 VPDC

■OUTLINE

The versatile panel display controller (VPDC) is a high-level display controller with functions for controlling large-capacity flat panel displays (hereinafter simply "panels") and for controlling raster-scanning CRT displays. In addition, since application software written for CRTs can be used as is when the VPDC BIOS is used, portable and transportable computers with panels can be configured easily. (Display switching between CRT and panel as necessary is possible.)

This VPDC is completely compatible with the IBM-PS/2 video graphics array(VGA). When a standard monitor is used, this compatibility requires no change to the BIOS or software whatsoever. Even if a non-standard monitor is used, compatibility can be achieved by simply setting the values of switches with the VPDC BIOS. There is no need to change the software at all. For example when an IBM monochrome monitor and 2-tone panel are used, color display software can be executed. (Monitors that can not display colors handle this with gray scaling and hatching.)

It can also be easily configured for higher level display systems, with a built-in color look-up table(LUT) for color mapping.

■FEATURES

- Compatible with the IBM VGA in register level (when CRT is used); CPU interface is PC-BUS specification.
- Since all the functions of the VGA have been included, the VGA board functions can be realized with few parts for IBM PC compatibles. Furthermore, LCD, plasma displays, and EL displays can be controlled as well.
- The VPDC can be connected to the following CRTs:
  - IBM monochrome display
  - IBM enhanced color display
  - IBM 8503 monochrome display
  - IBM 8512 color display
  - IBM 8513 color display
  - IBM color display
  - NEC Multisync monitor (and models from other manufacturers that have the same functions)
- The VPDC can be connected to panels(LCD, plasma, EL and various other panels) with the following resolutions:
  - 640×200 - 320×200 - 640×400 - 720×400 - 640×480 - 640×350
- Eight 64K×4 dynamic RAM chips or eight 32K×8 static RAM chips can be used for video RAM (for a maximum of 256 KB)
- Up to 16 colors can be displayed for 640×480 dots.
- 1-screen panels and 2-screen panels can be used.
- The duty cycle can be set as high as 1/512 when a 2-screen panel is used.
- The AC signal for the LCD panel can be set freely in units of 1 Horizontal scan (with a maximum pulse width of 1024h).
- Data can be sent to the panel in parallel 4 or 8 bits at a time or serially.
- Color liquid crystal displays can be used (320×200 dots by 8 colors)
- 16-shade display is possible with panels and monochrome monitors. (Of these 16, 9 can be converted into 9 hatching patterns.)
- Screen display position compensation is possible when using panels the same as for CRTs (Screen center can also be adjusted).
- Multi-raster scan function (display taking into account the aspect ratio)
- Built-in look-up table (LUT) for color mapping
- CMOS, 128-pin QFP

■ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings (with Vss = 0.0V as the standard)

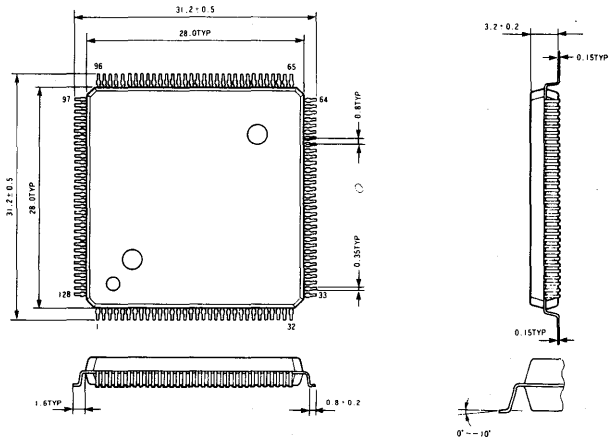
Item	Symbol	Min.	Max.	Unit
Power supply voltage	V_{DD}	-0.3	7.0	V
Input voltage	V_I	-0.3	V_{DD}+0.3	V
Output voltage	V_O	-0.2	V_{DD}+0.3	V
Operating ambient temperature	V_{OP}	0	70	°C
Storage temperature	T_{STG}	-50	125	°C

Recommended Operating Conditions (with Vss = 0.0V as the standard)

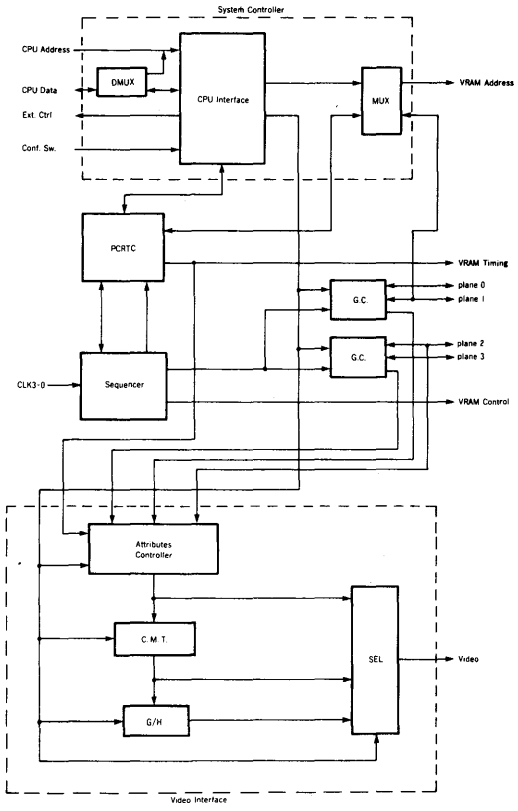
Item	Symbol	Min.	Typ.	Max.	Unit.
Power supply voltage	V_{DD}	4.75	5.00	5.25	V
Operating ambient temperature	T_{OP}	0	25	70	℃
Low level input voltage*	V_{IL}			0.8	V
High level input voltage*	V_{IH}	2.0			V

*: except for clock input

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



GRAPHICS

Enhanced Video Display Processor

V9938C E-VDP

■ OUTLINE

V9938 (E-VDP) is a video display processor using an N-channel· silicon gate MOS and a 64-pin shrink DIL plastic package. TMS9918A is software compatible.

■ FEATURES

- 5V power supply
- Linear RGB and composite video output
- Built-in palette for displays in up to 512 colors.
- Maximum of 512 x 424 pixels and 16 colors.
- Bit mapped graphics
- A maximum of 256 colors can be displayed at the same time.
- 16 k-byte ~ 128 k-byte display memory
- 16K x 1b, 16K x 4b, 64K x 1b, 64K x 4b DRAMs can be used.
- 256 address, 4ms DRAM auto refresh.
- Expansion video memory can be connected.
- Built-in mouse and light pen interfaces.
- Eight sprites can be displayed for each horizontal line.
- Colors for sprites can be specified for each horizontal line.
- Area move, line, search and other commands.
- Logical operation function.
- Addresses can be specified by coordinates.
- External sync is possible.
- Superimpose is possible.
- Digitize is possible.
- Multi E-VDP configurations are possible.
- Additional external color palettes using the Color-Bus output.

■ ELECTRICAL CHARACTERISTICS

1. Maximum Ratings

Symbol	Item	Rating	Unit
Vcc	Power supply voltage	−0.5 ~ +7.0	V
Vin	Input voltage	−0.5 ~ +7.0	V
Ts	Storage temperature	−50 ~ +125	°C
To	Operating temperature	0 ~ +70	°C

2. Recommended Operating Conditions

Symbol	Item	Minimum	Typical	Maximum	Unit
Vcc	Power supply voltage	4.75	5.00	5.25	V
Vss	Power supply voltage		0		V
TA	Operating ambient temperature	0		70	°C
VIL 1	Low level input voltage (group 1)	−0.3		0.8	V
VIL 2	Low level input voltage (group 2)	−0.3		0.8	V
VIL 3	External clock low level input voltage (group 3)	−0.3		0.8	V
VIH 1	High level input voltage (group 1)	2.2		Vcc	V
VIH 2	High level input voltage (group 2)	2.2		Vcc	V
VIH 3	External clock high level input voltage (group 3)	3.5		Vcc	V

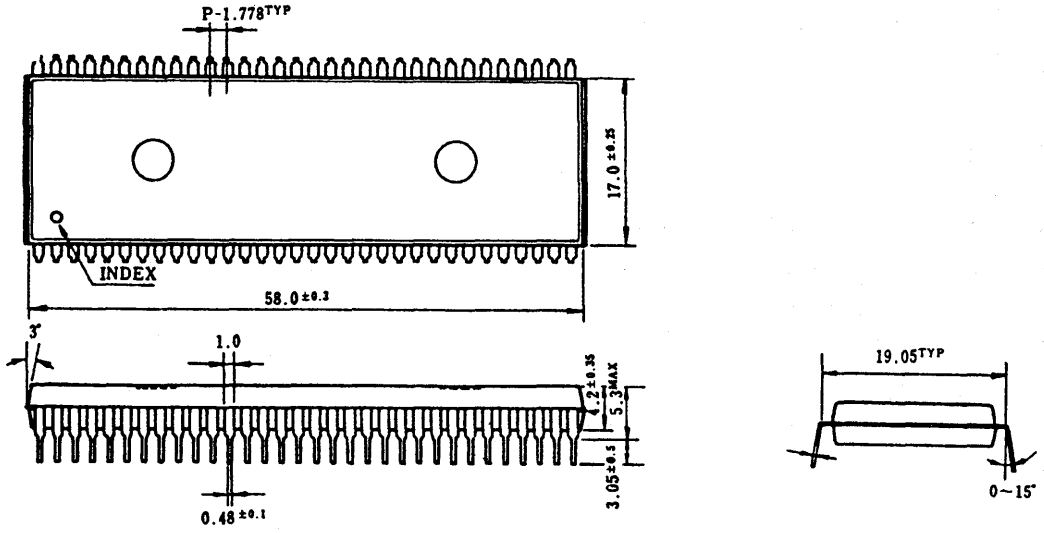
Note: Group 1 $\overline{CSR}$, RDO-7, CO-7, $\overline{LPS}$, $\overline{LPD}$, $\overline{RESET}$, $\overline{DLCLK}$
Group 2 CDO-7, MODE 0, MODE 1, $\overline{CSW}$
Group 3 XTAL 1, XTAL 2

3. AC Characteristics

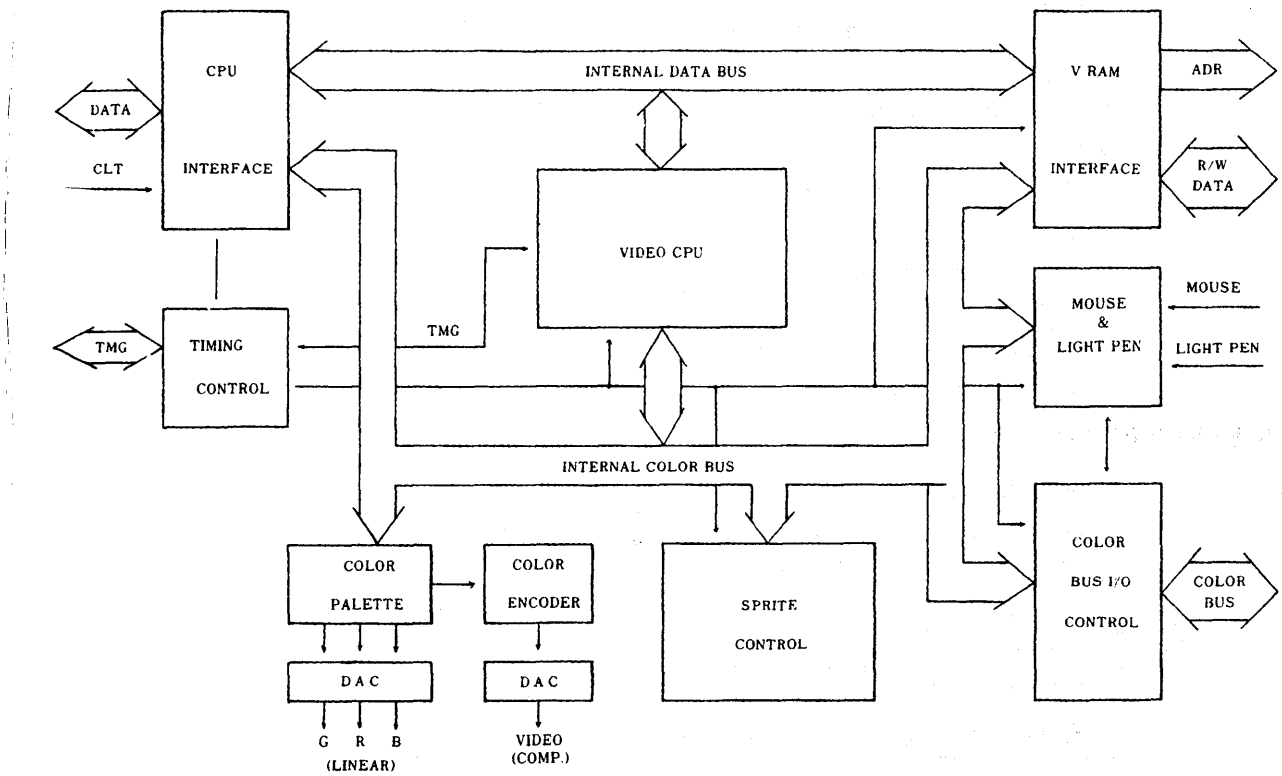
Symbol	Item	Condition	Minimum	Typical	Maximum	Unit
VOL 4	Low level output voltage (group 4)	IOL = 1.6mA			0.4	V
VOL 5	Low level output voltage (group 5)	IOL = 1.6mA			0.4	V
VOL 6	Low level output voltage (group 6)	IOL = 10mA			0.4	V
VOL 7	Low level output voltage (group 7)	IOL = 1.6mA			0.4	V
VOH 4	High level output voltage (group 4)	IOH = 100μA	2.4			V
VOH 5	High level output voltage (group 5)	IOH = 60μA	2.7			V
ILI	In-put leak current				10	μA
ILO	Output leak current (when floating)				25	μA
Icc	Current consumption				230	mA

Note: Group 4 CDO-7, RDO-7, ADO-7, $\overline{VDS}$, CBDR, CPUCLK, CO-7
Group 5 $\overline{RAS}$, $\overline{CAS\ 0}$, $\overline{CAS\ 1}$, $\overline{CASX}$, R/$\overline{W}$
Group 6 $\overline{DLCLK}$, $\overline{DHCLK}$
Group 7 $\overline{INT}$

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



GRAPHICS

Enhanced Video Display Processor

V9958 E-VDP II

■ OUTLINE

V9958 (E-VDP II) is a video display processor using an N-channel silicon gate MOS and a 64-pin shrink DIL plastic package. It is software compatible with TMS9918A and V9938.

■ FEATURES

- 5V power supply.
- Outputs linear RGB.
- Built-in color palette for display in up to 512 colors.
- Capable of simultaneous display of 19,268 colors by using YJK system display.
- Capable of displaying up to 512 × 424 pixels and 16 colors.
- Bit mapped graphics.
- Capable of displaying maximum of 256 colors simultaneously.
- 16K byte ~ 128K byte useable for display memory.
- 16K × 1b, 16K × 4b, 64K × 1b and 64K × 4b DRAMs are useable.
- 256 addresses, 4ms auto refresh function of DRAM.
- Expansion video memory can be connected.
- Eight sprites can be displayed for each horizontal line.
- Colors for sprites can be specified for each horizontal line.
- Area move, line, search and other commands.
- Command function usable in every display mode.
- Logical operation function.
- Addresses can be specified by coordinates.
- Capable of external synchronization.
- Capable of superimposition.
- Capable of digitization.
- Multi E-VDP II configurations are possible.
- External color palettes can be added by utilizing color-bus output.
- Vertical and horizontal scroll function.
- Wait function to CPU.

■ ELECTRICAL CHARACTERISTICS

1. Maximum Ratings

Symbol	Item	Rating	Unit
V_{DD}	Power supply voltage	−0.5 ~ +7.0	V
Vin	Input voltage	−0.5 ~ +7.0	V
Ts	Storage temperature	−50 ~ +125	°C
To	Operating temperature	0 ~ +70	°C

2. Recommended Operating Conditions

Symbol	Item	Minimum	Typical	Maximum	Unit
V_{DD}	Power supply voltage	4.75	5.00	5.25	V
V_{SS}	Power supply voltage		0		V
T_A	Operating ambient temperature	0		70	°C
V_{IL} 1	Low level input voltage (group 1)	−0.3		0.8	V
V_{IL} 2	Low level input voltage (group 2)	−0.3		0.8	V
V_{IL} 3	External clock low level input voltage (group 3)	−0.3		0.8	V
V_{IH} 1	High level input voltage (group 1)	2.2		V_{DD}	V
V_{IH} 2	High level input voltage (group 2)	2.2		V_{DD}	V
V_{IH} 3	External clock high level input voltage (group 3)	3.5		V_{DD}	V

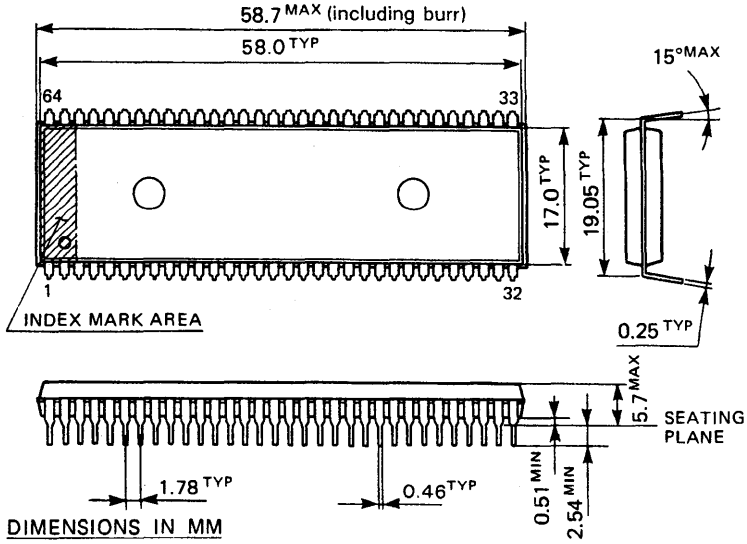
Note: Group 1 $\overline{CSR}$, RD0-7, C0-7, $\overline{LPS}$, $\overline{LPD}$, $\overline{RESET}$, $\overline{DLCLK}$, $\overline{VRESET}$, $\overline{HRESET}$
Group 2 CD0-7, MODE 0, MODE 1, $\overline{CSW}$
Group 3 XTAL 1, XTAL 2

3. DC Characteristics

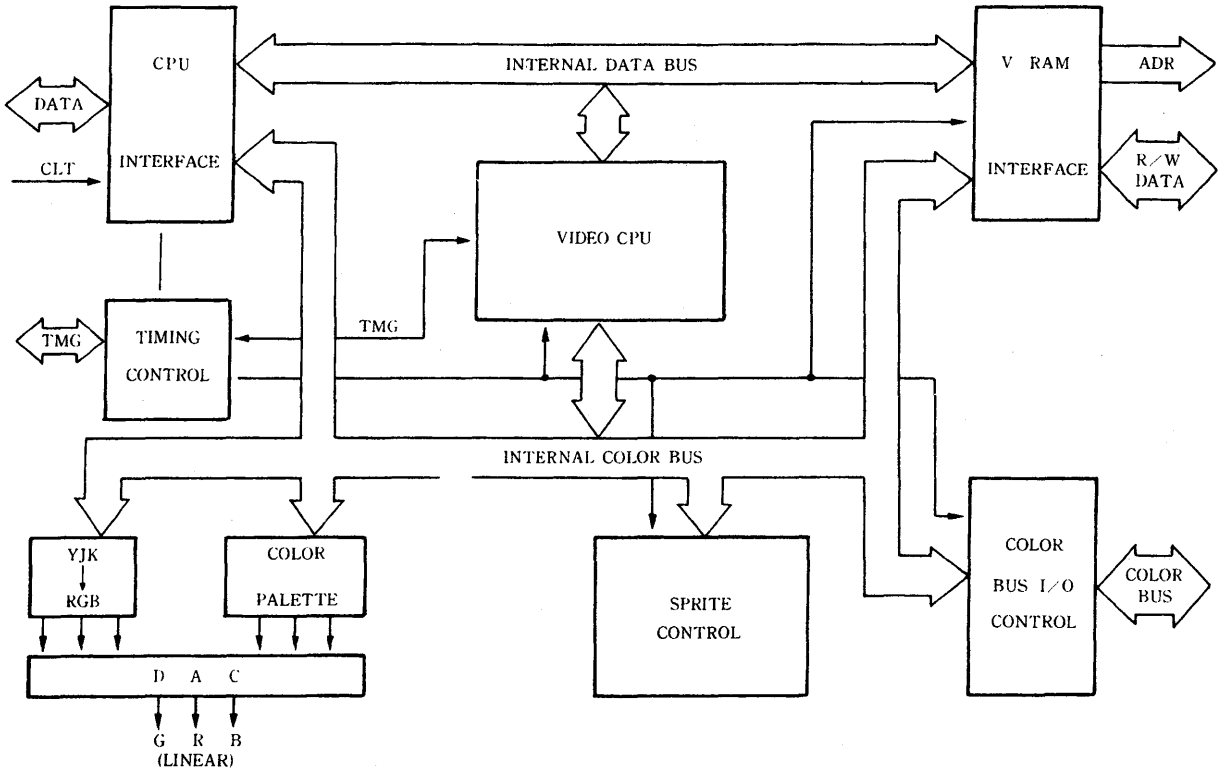
Symbol	Item	Condition	Minimum	Typical	Maximum	Unit
VOL 4	Low level output voltage (group 4)	IOL = 1.6mA			0.4	V
VOL 5	Low level output voltage (group 5)	IOL = 1.6mA			0.4	V
VOL 6	Low level output voltage (group 6)	IOL = 10mA			0.4	V
VOL 7	Low level output voltage (group 7)	IOL = 1.6mA			0.4	V
VOL 4	High level output voltage (group 4)	IOH = 100μA	2.4			V
VOL 5	High level output voltage (group 5)	IOH = 60μA	2.7			V
ILI	Input leak current				10	μA
ILO	Output leak current (when floating)				25	μA
IDD	Current consumption				230	mA

Note: Group 4 CD0-7, RD0-7, AD0-7, $\overline{VDS}$, CBDR, CPUCLK/$\overline{VDS}$, C0-7, $\overline{HSYNC}$, $\overline{CSYNC}$, $\overline{WAIT}$, $\overline{YS}$
Group 5 $\overline{RAS}$, $\overline{CAS\ 0}$, $\overline{CAS\ 1}$, $\overline{CASX}$, R/$\overline{W}$
Group 6 $\overline{DLCLK}$, $\overline{DHCLK}$
Group 7 $\overline{INT}$

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



COMMUNICATION

4800 bps MODEM CHIP SET

YM3405 Modem Signal Processing LSI

YM3022 Analog-digital interface LSI

■ OUTLINE

The YM3405 chip is a modem signal processing LSI for conducting data transfers at 4800bps (2400bps during fallbacks) over voice grade channels by means of differential phase modulation in conformity with the CCITT V.27ter recommendations.

In addition to the PSK modulator-demodulator circuit, scrambler/descrambler, automatic equalizer, training sequencer, AGC control circuit, and other similar functions called for in the CCITT V.27ter recommendations, the YM3405 chip also offers the 75bps FSK modulator function necessary for the CAPTAIN adapter modem, the 300bps FSK modulator-demodulator function required for G3 facsimiles, and functions for producing and transmitting tones of various frequencies. These features make it ideal for application in such equipment as standard modems used in G3 facsimiles, CAPTAIN adapter modems, and personal computer communications modems which use the system recommended by the Japanese Ministry of Posts and Telecommunications.

The YM3022 chip, developed at the same time as the YM3405, is an analog-digital interface LSI for the YM3405. It houses AGC, S & H, AD conversion, and DA conversion circuits and is designed to function as the interface between the YM3405, which conducts digital signal processing, and an analog filter, for which most hybrid ICs on the market may be used. Use of the YM3022 permits a major reduction in the number of components required for the YM3405's peripheral circuits.

■ FEATURES

Here are the major features of the YM3405 - YM3022 4800bps modem chip set.

- The YM3405 provides the following modulator-demodulator functions conforming to CCITT recommendations:
  4800/2400bps modulator-demodulator function, automatic equalizer, scrambler/ descrambler, and training sequencer called for in CCITT recommendation V.27ter (half-duplex);
  Channel 2 (higher frequency range at 300bps) modulator- demodulator function (half duplex) called for in CCITT recommendation V.21;
  Backward channel (75bps) modulator function called for in CCITT recommendation V.23.
- Full duplex communications are also possible through the combined use of V.27ter reception and V.23 backward channel transmission (CAPTAIN mode).
- The YM3405 contains tone transmission functions for producing and sending tones of various frequencies.
- The YM3022 contains AGC, S&H, AD conversion, and DA conversion circuits.
- The YM3405 has terminals for a 4.9152MHz crystal oscillator.
- Both operate with a 5V power supply and are CMOS process.
- The YM3405 comes in a 40-pin DIL package and the YM3022 comes in a 16-pin DIL package.

■ ELECTRICAL

YM3405 Electrical Characteristics

(1) Maximum ratings (V_{SS} = 0V)

Item	Symbol	Rated value	Unit
Power supply voltage	V_{DD}	−0.5 ~ +7.0	V
Input voltage	V_{IN}	−0.5 ~ V_{DD} +0.5	V
Output voltage	V_{OUT}	−0.5 ~ V_{DD} +0.5	V
Input current	I_{IN}	−20 ~ +20	mA
Storage temperature	T_{STG}	−50 ~ +125	°C

(2) Recommended operating conditions (V_{SS} = 0V)

Item	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{DD}	4.75	5.0	5.25	V
Clock frequencies	F_{CLK}	4.9148	4.9152	4.9156	MHz
Operational temperature	T_{OPR}	0	25	70	°C

(3) Electrical characteristics under the recommended operating conditions

Item	Symbol	Condition	Min.	Max.	Unit
Power consumption	I_{DD}	—	—	40	mA
High level input voltage	V_{IH}		2.0	—	V
Low level input voltage	V_{IL}	—	—	0.8	V
Input leakage	I_L	(NOTE 1)	−10	+10	μA
High level output voltage	V_{OH}	I_{OH} = −1.0 mA	V_{DD}−1.0	—	V
Low level output voltage	V_{OL}	I_{OL} = 1.0 mA	—	0.4	V
Output delay time	td	C_L = 100pF; delay from rise edge of CLKOUT	−20	+150	nsec
External clock duty	—	When external clock used.	40	60	%

Note 1: does not apply to $\overline{TESTOE}$, $\overline{TESTSB}$, $\overline{TESTLD}$, and XTAL1.

YM3022 Electrical Characteristics

(1) Maximum ratings (V_{SS} = 0V)

Item	Symbol	Rated value	Unit
Power supply voltage	V_{DD}	−0.5 ~ +15.0	V
Input voltage	V_{IN}	−0.5 ~ V_{DD} +0.5	V
Output voltage	V_{OUT}	−0.5 ~ V_{DD} +0.5	V
Input current	I_{IN}	−20 ~ +20	mA
Storage temperature	T_{STG}	−50 ~ +125	°C

(2) Recommended operating conditions (V_{SS} = 0V)

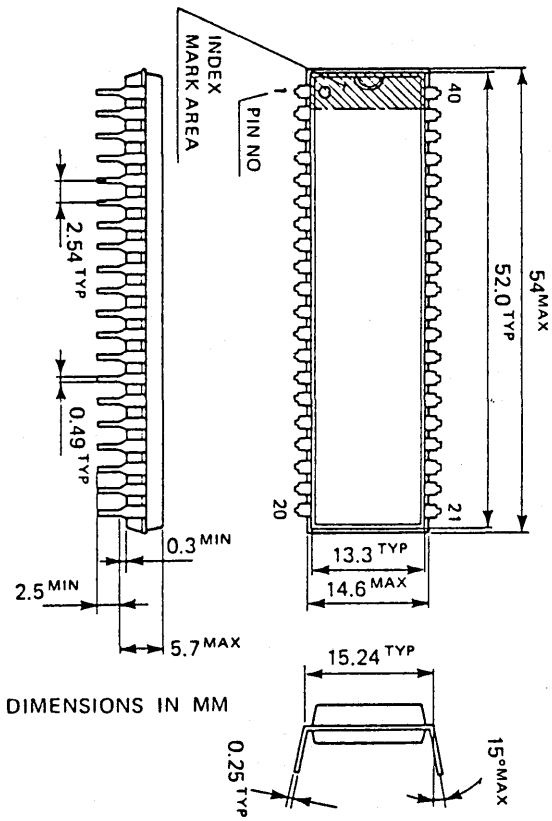
Item	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{DD}	4.75	5.0	5.25	V
Clock frequencies	F_{CLK}	1.0	2.46	5.0	MHz
Operational temperature	T_{OPR}	0	25	70	°C

(3) Electrical characteristics under the recommended operating conditions

Item	Symbol	Condition	Min.	Max.	Unit
Power consumption	I_{DD}	—	—	6.0	mA
High level input voltage	V_{IH}	CLK terminal ADST terminal DAI terminal	3.3	—	V
Low level input voltage	V_{IL}		—	1.5	V
Input leakage	I_L		−10	+10	μA
High level output voltage	V_{OH}	ADD terminal	V_{DD}−1.0		V
Low level output voltage	V_{OL}		—	0.4	V
Output delay time	td	C_L = 50pF; delay from rise edge of CLKOUT	0	+150	nsec

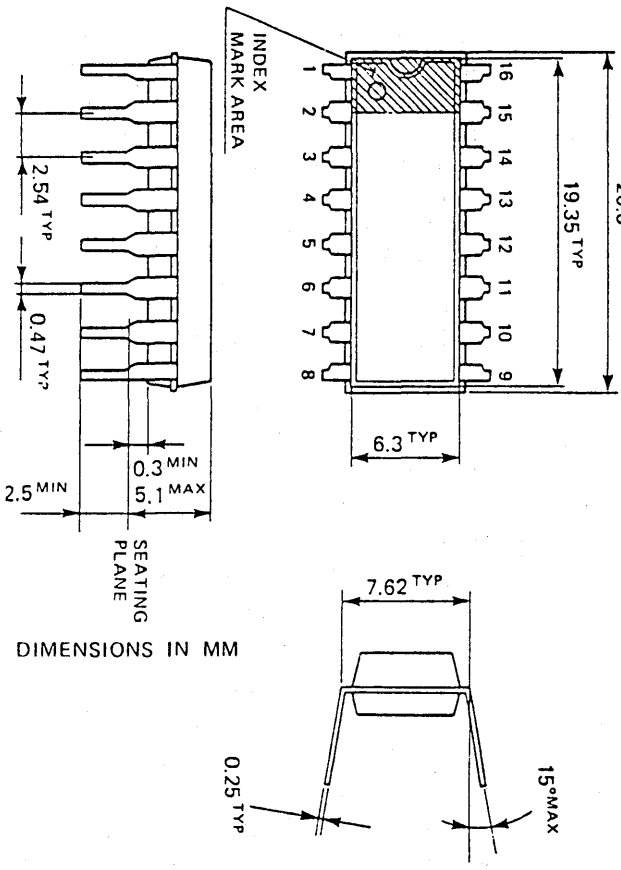
■ OUTLINE DIMENSIONS

YM3405



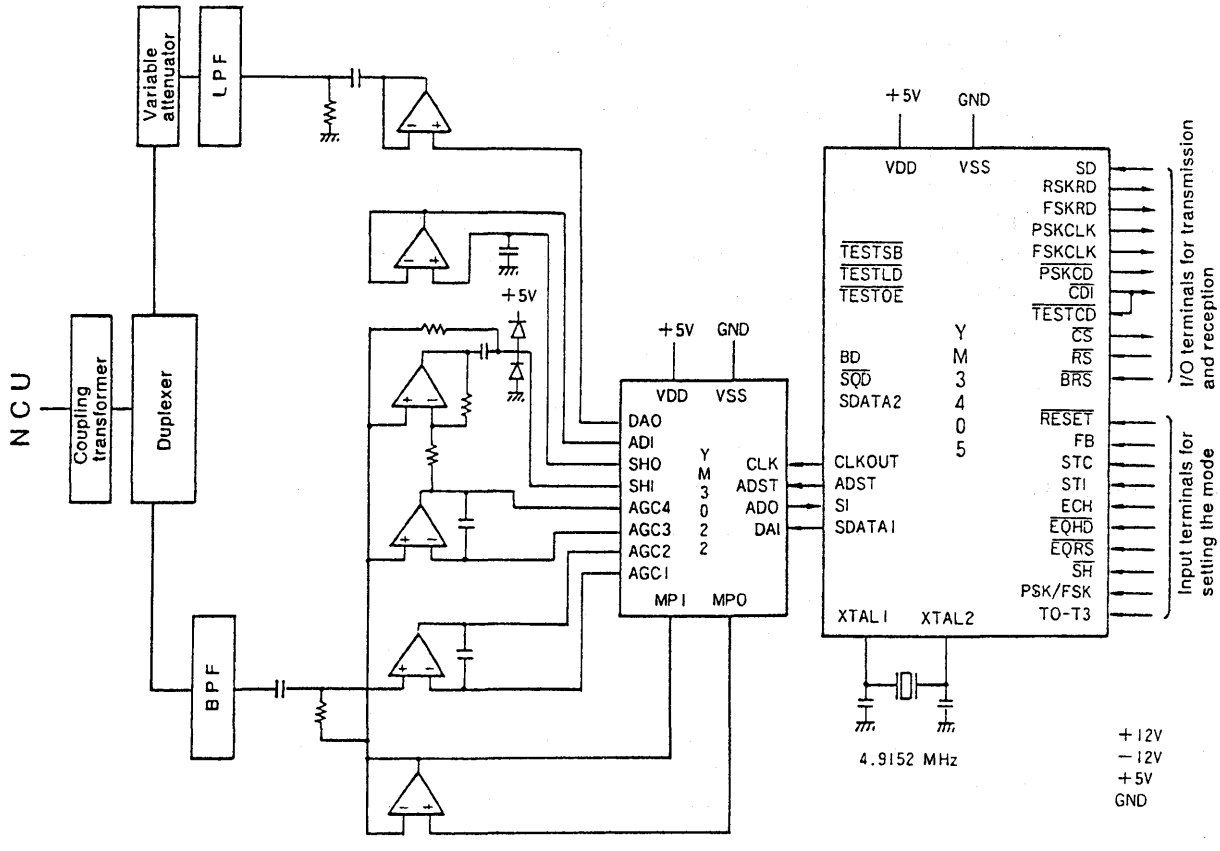
DIMENSIONS IN MM

YM3022



DIMENSIONS IN MM

■ BLOCK DIAGRAM



COMMUNICATION

9600bps FAX MODEM

YM7109 MD96FX

■ OUTLINE

The YM7109 LSI is a one-chip modem for half-duplex synchronous data transfer at 9600 bps, 7200 bps, 4800 bps, 2400 bps, and 300 bps (CCITT V.29, V.27ter, V.21 ch2). With its built-in programmable dual tone originating function and programmable tone detection function, this LSI is designed for use with a public telephone line network and is ideal for modem applications for G3 facsimile machines.

In addition, the YM7109 is equipped with function for modulation into full duplex (CCITT V.21 and BELL 103) and a 75 bps (CCITT V.23 Backward channel) transmission function. It can thus also be used as the modem for telecommunications by personal computer or as a CAPTAIN adapter.

The YM7109 also has a built-in interface register which can connect to the data bus of a microprocessor, allowing reading and writing to and from that data bus. By accessing this interface register via a parallel interface, you can set the operating mode, set various parameters, read status flags, transfer the data to be transmitted or received, operate the modem and so on. The transfer of the transmit and receive data as well as modem operation can also be performed via a serial interface. The YM7109 is fabricated in a 40 pin dip unit. Because of its low power consumption thanks to CMOS, the full capability of the LSI can be facilitated with 5V battery power supply, allowing much space to work with in terms of designing. This is a great plus for portability.

■ FEATURES

- CCITT V.29 (9600 bps/7200 bps) — Half duplex, synchronous
  V.27ter (4800 bps/2400 bps) — Half duplex, synchronous
  V.21 ch 2 (300 bps) — Half duplex, synchronous
  V.23 Backward — Channel (75 bps) Transmission only
  V.21 (300 bps) — Full duplex
- BELL 103 (300 bps) — Full duplex
- In CAPTAIN mode, full-duplex reception using V.27ter and full-duplex transmission using V.23 (75 bps) is possible.
- Compatible with the public phone line network (two-wire system)
- Dual tone originating function (programmable)
- Tone detection function (programmable)
- DTMF detection function (fixed)
- Function for detecting flag patterns of V.21 ch2
- Transmission level: 0 dBm to −15 dBm (programmable)
- Reception dynamic level: 0 dBm to −43 dBm (programmable)
- Auto equalizer function, and subscriber cable equalizer function
- Built-in bandpass filter for transmission and reception, A/D converter, D/A converter, and AGC (Automatic Gain Control)
- Parallel interface and serial (CCITT V.24) interface
- 40-pin DIP, 64-pin QFP, 68-pin PLCC package
- Low power consumption due to CMOS use (Typ. 200mw, Max. 300mw)
- 5V single power supply

■ ELECTRICAL CHARACTERISTICS

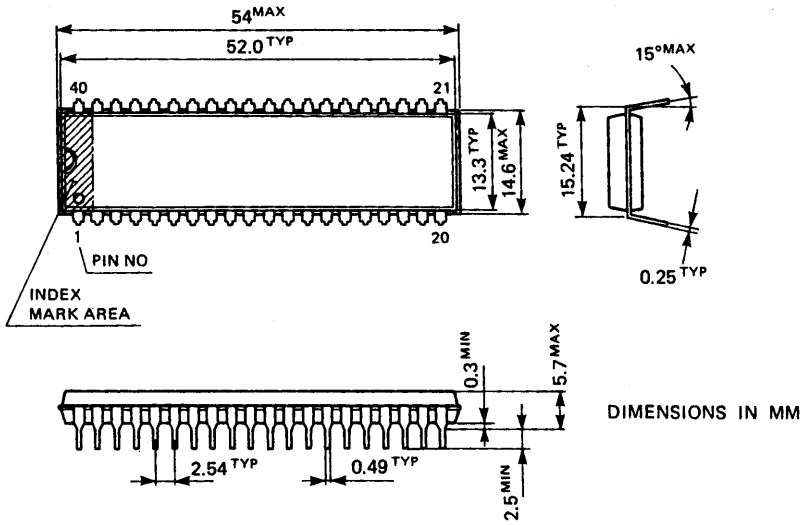
1. Maximum Ratings (VSS shall be 0V)

ITEM	SYMBOL	RATING		UNIT
		Min.	Max.	
Supply voltage	V_{DD}	−0.5	7.0	V
Input voltage	V_I	−0.5	V_{DD} + 0.5	V
Output voltage	V_O	−0.5	V_{DD} + 0.5	V
Storage temperature	T_{STG}	−50	+125	°C

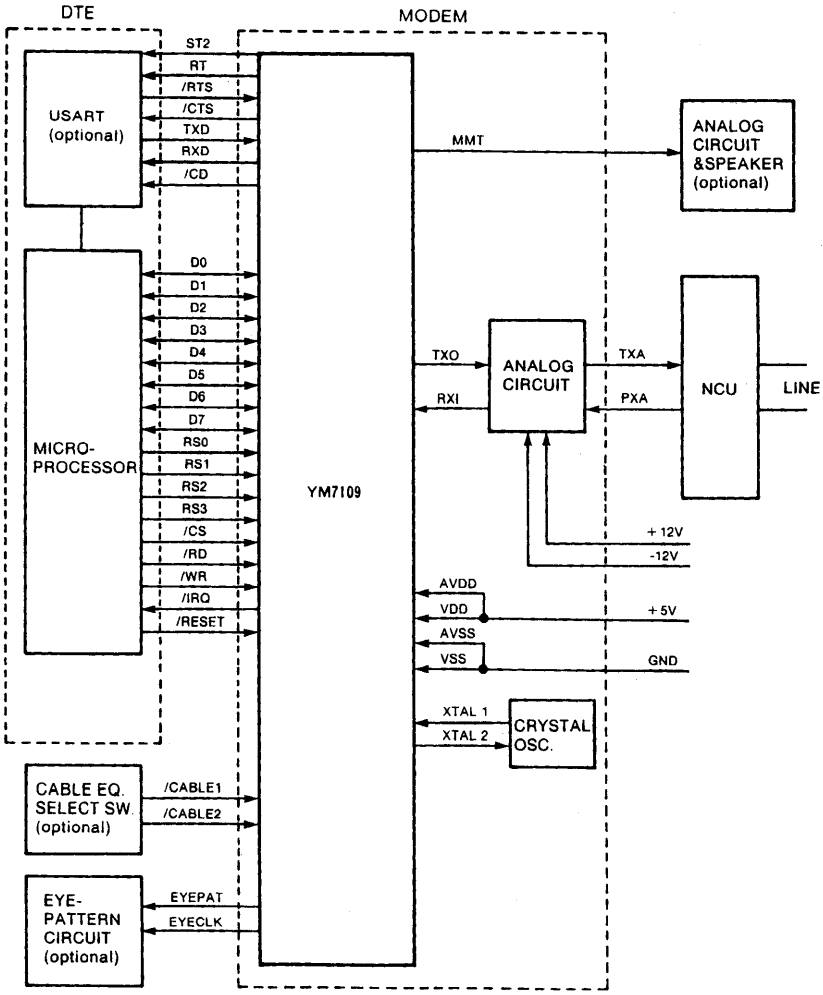
2. Recommended Operating Conditions (VSS shall be 0V)

ITEM	SYMBOL	RATING			UNIT
		Min.	Typ.	Max.	
Supply voltage	VDD	4.75	5.0	5.25	V
Ambient operating temperature	Ta	0	25	70	°C
Clock frequency	fCLK	9.82942	9.83040	9.83138	MHz

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



COMMUNICATION

MIDI (Musical Instrument Digital Interface) Communication & Service Controller

YM3802 MCS

■ OUTLINE

The YM3802 is an LSI device featuring an asynchronous serial communication interface, a frequency divider that acts a communication rate generator, an interface for the cassette tape recorder, transmit/receive data buffers, timers, counters and a parallel input/output port. With this LSI a part of the MIDI data processing can be performed by hardware.

The YM3802 LSI has two output pins and three counters that synchronize with the MIDI clock and the tape SYNC can be easily realized. The MIDI clock is generated by the MIDI clock timer, the tape SYNC signal or the clock message which is contained in the received serial data. Another way of the generation of the MIDI clock is a process with the host CPU control. This LSI has the priority transmission and reception capability of the MIDI system real-time message over other messages and also can support the processing of the system exclusive message.

Each of the MIDI counters can be utilized as general-purpose timer/counter.

■ FEATURES

- Serial communication
  7- or 8-bits ..... Character
  1- or 4-bits ..... Parity bit,
  1- or 2-bits ..... Stop bit,
  Start bit error detection,
  Automatic break detection and break character generation,
  Character length, Types of parity and stop bits and communication rate are selectable for transmission and reception separately.
- MIDI support functions
  SYNC out, CLOCK out; output of a pulse signal synchronized to the system real-time message.
  Automatic transmitting function, priority transmitting function and priority receiving function (without involving the receiving FIFO buffer) of the system real-time message.
- 8- and 15-bit counters for counting the interpolated, high-accuracy signal of the MIDI clock.
- Special 14-bit timer for determining MIDI clock generation timing. Detecting function of the MIDI clock from the received serial data.
- Tape SYNC function.
- Automatic output of the tape SYNC signal
- Active sense function
- ID code check function for the system exclusive message.

■ ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

ITEM	SYMBOL	RATING	UNITS
Supply voltage	V_{DD}	−0.3 ~ +7.0	V
Input voltage	V_I	−0.3 ~ +0.5	V
Operating temperature	Top	0 ~ 70	°C
Storage temperature	Tstg	−50 ~ 125	°C

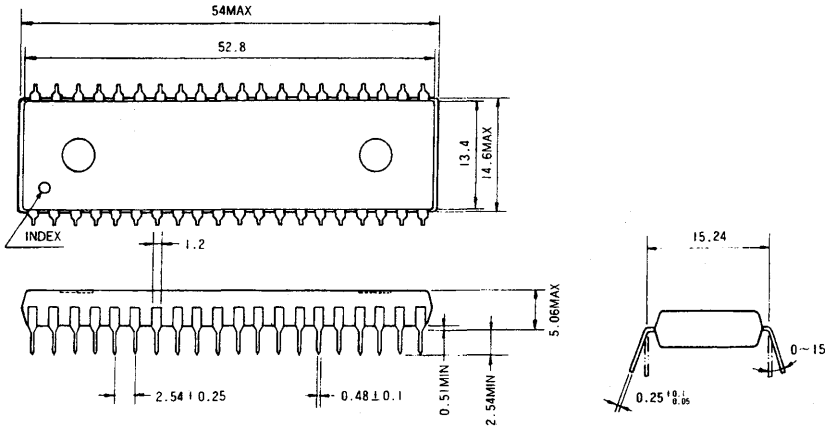
Recommended Operating Conditions (Ta = 0~70°C)

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNITS
Supply voltage	V_{DD}	4.75	5.00	5.25	V
Operating temperature	T_{OP}	0		70	°C

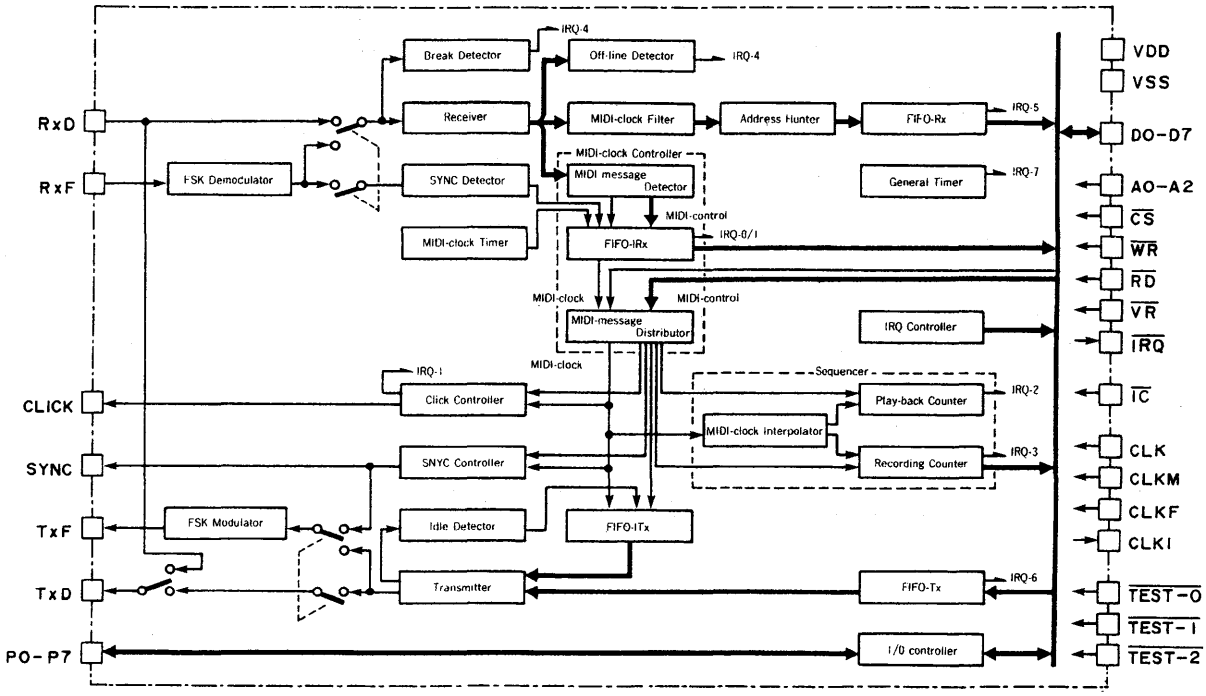
DC characteristics

ITEM	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input low level voltage	V_{IL}		−0.3	—	0.8	V
Input high level voltage	V_{IH}		2.0	—	V_{DD}+0.5	V
Input leakage current	I_{LK}	V_I = 0 ~ 5V (Except for the pins with pull-up registers)	—	—	10	μA
Pull-up resister	Ru	($\overline{TEST0}$ ~ $\overline{TEST2}$, $\overline{IC}$)	100	—	1000	KΩ
Output low level voltage	V_{OL}	I_{OL} = 2mA (P0 ~ P7, D0 ~ D7, $\overline{IRQ}$)	Vss	—	0.4	V
Output low level voltage	V_{OL}	I_{OL} = 1mA (Output terminals other than shown above)	Vss	—	0.4	V
Output high level voltage	I_{OL}	I_{OH} = −1mA (Except for $\overline{IRQ}$)	4.0	—	V_{DD}	V
Output leakage current	I_{OL}	V_O = 0 ~ 5V	—	—	10	μA
Power supply current	I_{DP}	V_{DD} = 5V	—	6	10	mA
Input capacitance	C_I	f = 1MHz			10	pF
Output load capacitance	C_{L1}	P0 ~ P7, D0 ~ D7, $\overline{IRQ}$			100	pF
	C_{L2}	Output terminals other than shown above			50	pF

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



SOUND SIGNAL PROCESSOR

Surround Processor

YM3411 SP

■ OUTLINE

The YM3411, a 16-pin DIP C-MOS LSI, permits to implement digital surround sound capabilities realized by Yamaha's digital audio technology.

As the LSI includes A/D and D/A converters, you can easily implement digital surround functions without any additional analog devices.

It has four delay lines each of which may be set for the maximum delay time of 30.24 msec, and outputs are two channels each of which is produced in each pair of delay channels added up digitally. So, the range of application is wide.

■ FEATURES

- Three kinds of surround mode are possible as preset modes without the use of any microcomputers.
- With a use of microcomputer, it is possible to set the four delay lines at different delay times and different volumes and to define parameters of a primary IIR digital low-pass filter.
- The internal signal format is of 14-bit floating point numbers.
- The built-in A/D and D/A converters are of floating type with high linearity.
- The built-in reference voltage generator for A/D Converter permits an easy interface with analog circuits.
- The A/D converter operates at the sampling frequency of 49.7 kHz. And its output signal data passes a 1/2 undersampling digital filter, so that high cost external input low-pass filter is not needed.
- The D/A converter operates at the sampling frequency of 99.4 kHz, following a built-in quadruple oversampling digital filter, so that high cost external output low-pass filter is not needed.

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings (VSS=0.0V)

Item	Symbol	Rating	Unit
Terminal voltage	VDD—VSS	−0.3~7.0	V
Operating temperature	TOP	0~70	°C
Storge temperature	Tstg	−50~125	°C

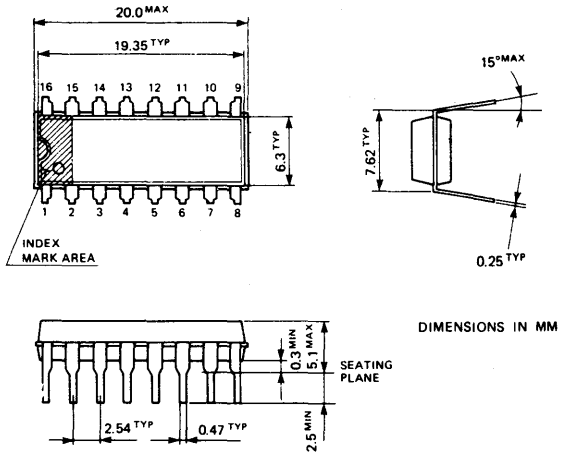
2. Recommended Operating Conditions (VSS=0.0V,TOP=0~70℃)

Item	Symbol	MIN.	TYP.	MAX.	Unit
Supply voltage	VDD	4.75	5.00	5.25	V
	VSS, AGND	0	0	0	V

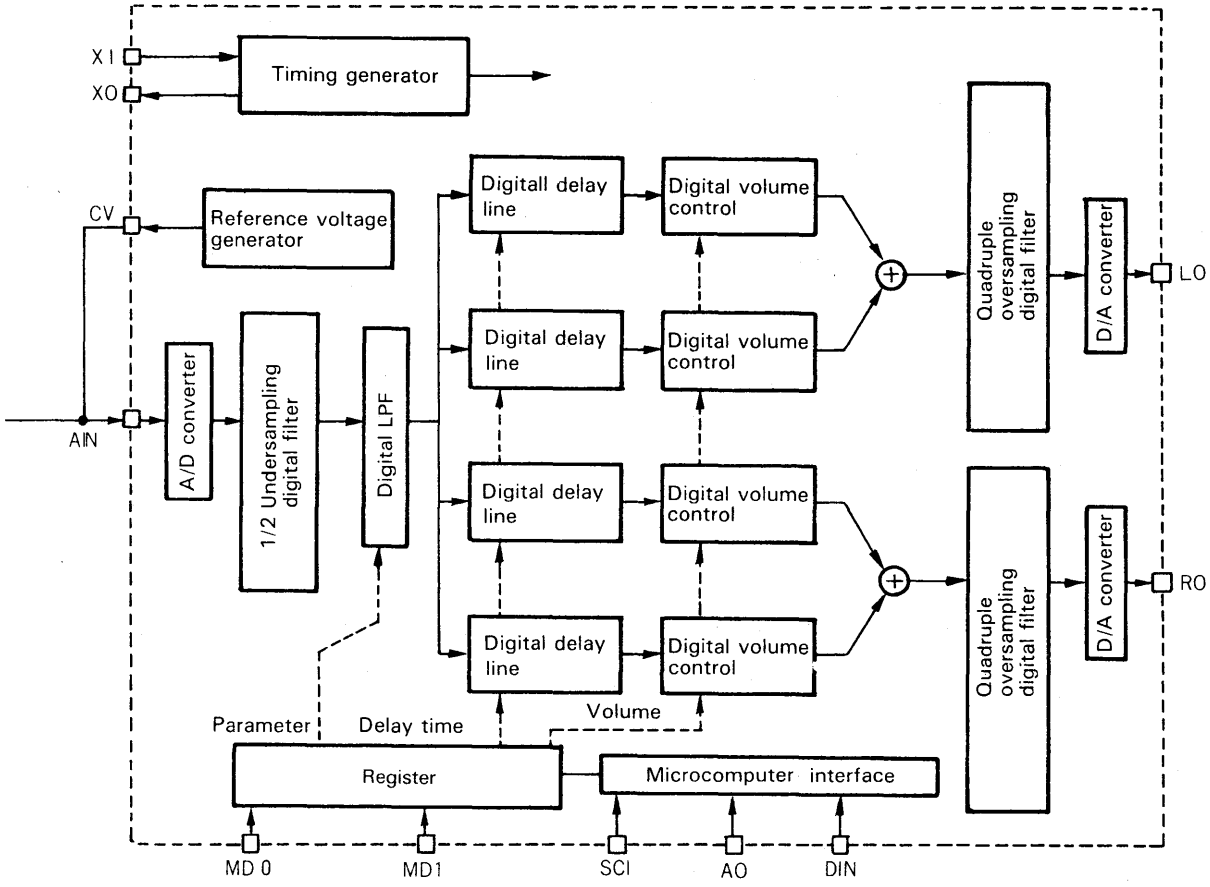
3. DC Characteristics (VDD=4.75~5.25V,TOP=0~70℃)

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Low-level input voltage	VIL		−0.3		0.8	V
High-level input voltage	VIH	Except XI	2.0		VDD	V
High-level input voltage	VIH	XI	4.0		VDD	V
Low-level output voltage	VOL	XO : IOL=0.2 mA	−0.3		0.4	V
High-level output voltage	VOH	XO : IOH=0.4 mA	4.0			V
Input current leak	ILK	VI=5V			10	μA
Supply current	IDD			20.0	30.0	mA
Input capacitance	CI	f=1 MHz			10	pF
Output capacitance	CO				10	pF
Pullup resistance	RPU	/IC, MD0, MD1	50		400	KΩ

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



SOUND SIGNAL PROCESSOR

Surround Processor-B

YM3428 SP-B

■ OUTLINE

The YM3428, a 16-pin DIP CMOS LSI, permits to implement quality digital surround sound capabilities realized by Yamaha's digital audio technology.

As the LSI includes A/D and D/A converters, you can easily implement digital surround functions without any additional analog devices.

It has four delay lines each of which may be set for the maximum delay time of 30.24 msec, and outputs are two channels each of which is produced in each pair of delay channels added up digitally. So, the range of application is wide.

■ FEATURES

- Three kinds of surround mode are possible as preset modes without the use of any microcomputers.
- With a use of microcomputer, it is possible to set the four delay lines at different delay times and different volumes and to define parameters of a primary IIR digital low-pass filter.
- The internal signal format is of 14-bit floating point numbers.
- The built-in A/D and D/A converters are of floating type with high linearity.
- The built-in reference voltage generator for A/D Converter permits an easy interface with analog circuits.
- The sampling frequency of A/D conversion is 24.9 kHz, so the bandwidth needed for surround sounds is secured.
- The D/A converter operates at the sampling frequency of 99.4 kHz, following a built-in quadruple oversampling digital filter, so that high cost external output low-pass filter is not needed.
- Distortion is as low as 0.22% (typical) at the maximum output at 1 kHz.

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings (VSS=0.0V)

Item	Symbol	Rating	Unit
Terminal voltage	VDD—VSS	−0.3 ~ 7.0	V
Operating temperature	TOP	0 ~ 70	°C
Storage temperature	Tstg	−50 ~ 125	°C

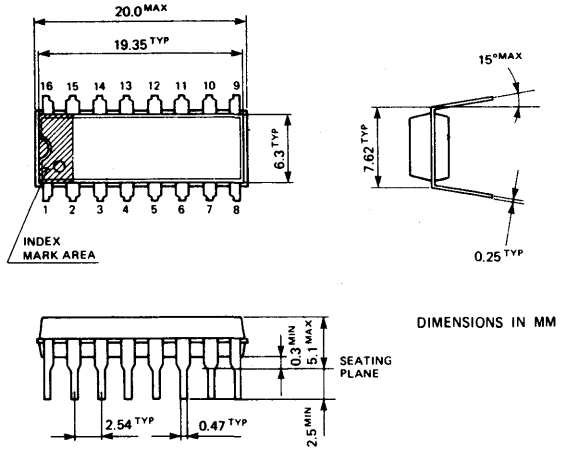
2. Recommended Operating Conditions (VSS=0.0V, TOP=0~70 ℃)

Item	Symbol	MIN.	TYP.	MAX.	Unit
Supply voltage	VDD	4.75	5.00	5.25	V
	VSS, AGND	0	0	0	V

3. DC Characteristics(VDD=4.75 ~ 5.25V, TOP=0 ~ 70 °C)

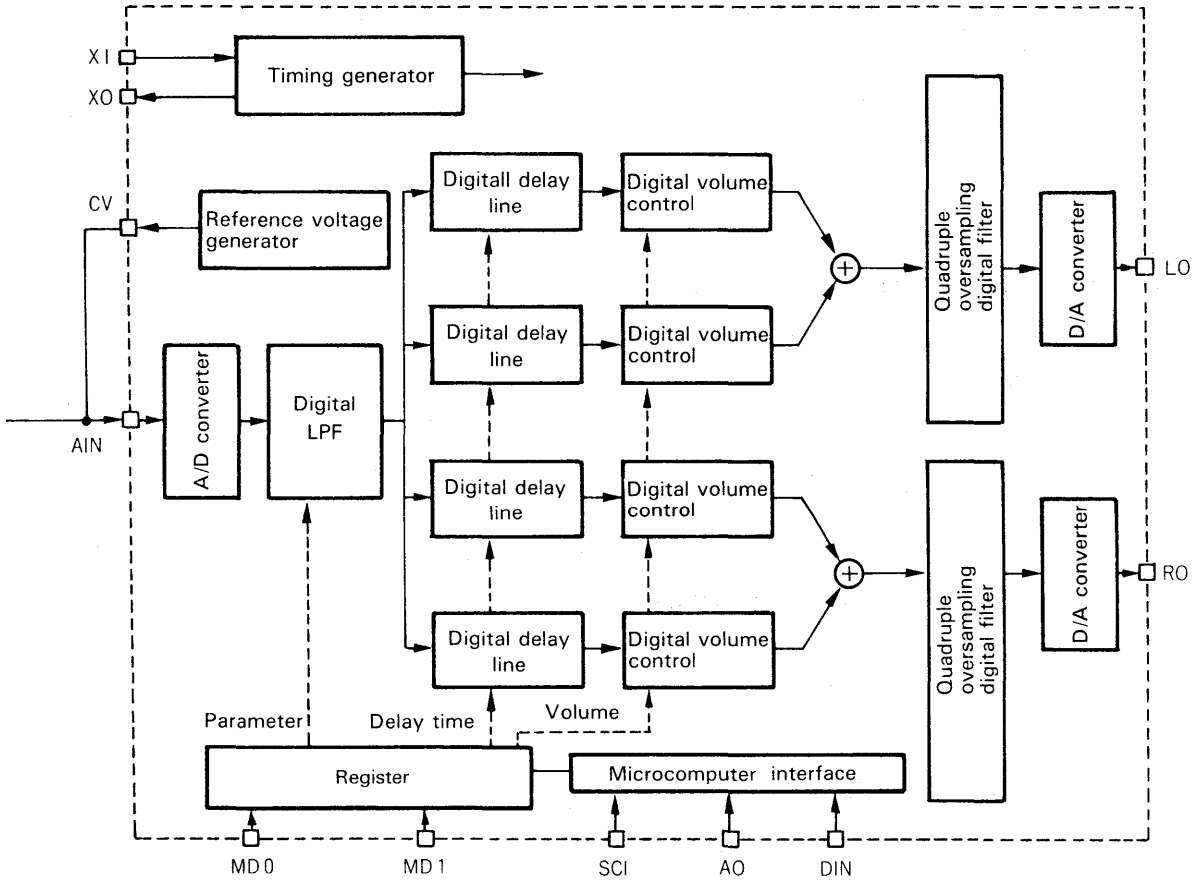
Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Low-level input voltage	VIL		−0.3		0.8	V
High-level input voltage	VIH	Except XI	2.0		VDD	V
High-level input voltage	VIH	XI	4.0		VDD	V
Low-level output voltage	VOL	XO : IOL=0.2 mA	−0.3		0.4	V
High-level output voltage	VOH	XO : IOH=0.4 mA	4.0			V
Input current leak	ILK	VI=5V			10	μA
Supply current	IDD			20.0	30.0	mA
Input capacitance	CI	f=1 MHz			10	pF
Output capacitance	CO				10	pF
Pullup resistance	RPU	/IC, MD0, MD1	50		400	KΩ

■ OUTLINE DIMENSIONS



DIMENSIONS IN MM

■ BLOCK DIAGRAM



SOUND SIGNAL PROCESSOR

Surround Processor 2

YM7128 SP-2

■OUTLINE

YM7128 is an LSI which has quality digital surround sound capabilities realized by Yamaha's digital audio technology.

The LSI has built-in A/D and D/A converters which enable digital surround sound processing for analog input/output without using any additional devices. Its eight digital delay lines may provide delay time of up to 100 msec. for each, and digital adding up of delay line signals for two-channel output assures a wide range of application.

■FEATURES

- The built-in RAM realizes digital delay time of 100 msec*, at the maximum.
- Feedback loop can be constructed for reverberation.
- Various surround effect can be obtained by controlling this processor with serial data from microprocessors.
- Digital attenuator is built in for surround sound volume control.
- Sampling frequency is 23.6 kHz*, and 14 bit floating A/D converter is built in.
- Two-times oversampling digital filter and 14 bit floating D/A converter are built in.
- 16 pin DIP packaged silicone gate CMOS LSI, operated by 5V.

NOTE: When XI clock frequency is 7.16 MHz (304 fs is required for X1 clock)

■ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Item	Symbol	Rating	Unit
Supply voltage	VDD	−0.3 ~ +7.0	V
Operating temperature	Top	−20 ~ +85	℃
Storage temperature	Tstg	−50 ~ +125	℃

Recommended Operating Conditions (Ta=25℃. VDD=5.0V)

Item	Symbol	Min	Typ	Max	Unit
Supply voltage	VDD	4.75	5.0	5.25	V
Operating temperature	Top	0	25	70	℃

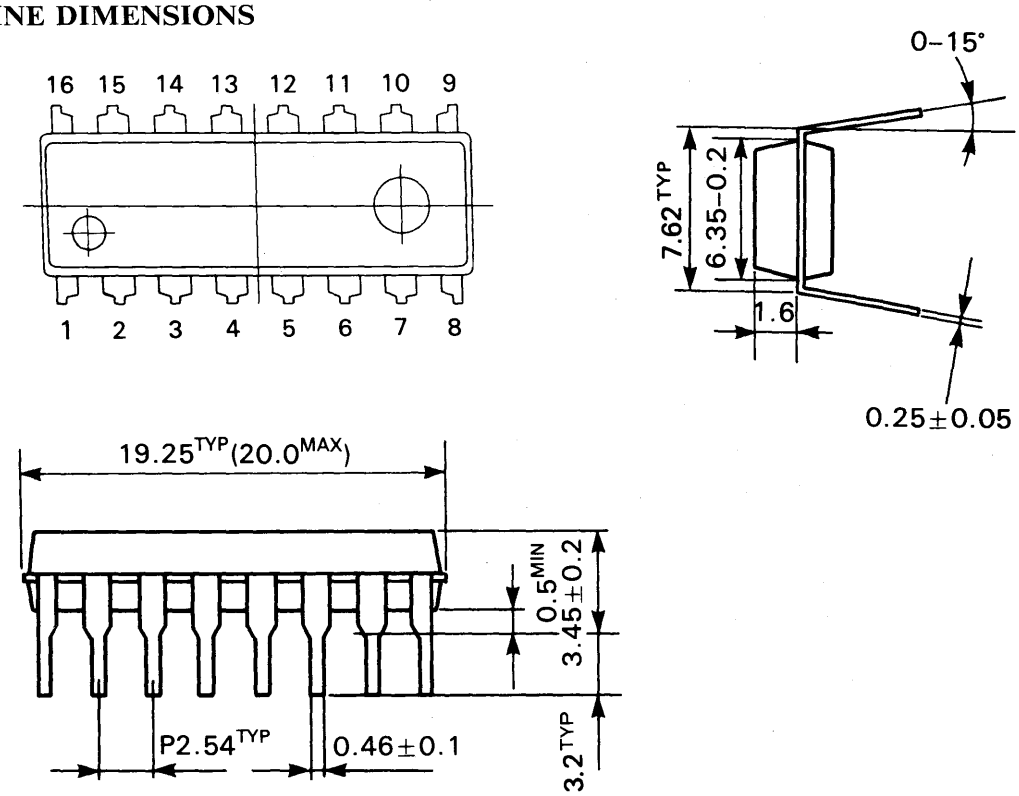
DC Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Current	IDD				50	mA
High-level input voltage (1)	VIH1		2.0			V ※1
Low-level input voltage (1)	VIL1				0.8	V ※1
High-level input voltage (2)	VIH2		4.0			V ※2
Low-level input voltage (2)	VIL2				0.8	V ※2
High-level output voltage	VOH	IOH=−0.4mA	4.0			V
Low-level output voltage	VOL	IOL=0.2mA			0.4	V
Input current leak	IIL	VI=0~5V	−10		10	μA
Input capacitance	CI			5.0	12.0	pF
Output eapacitance	CO				10.0	pF

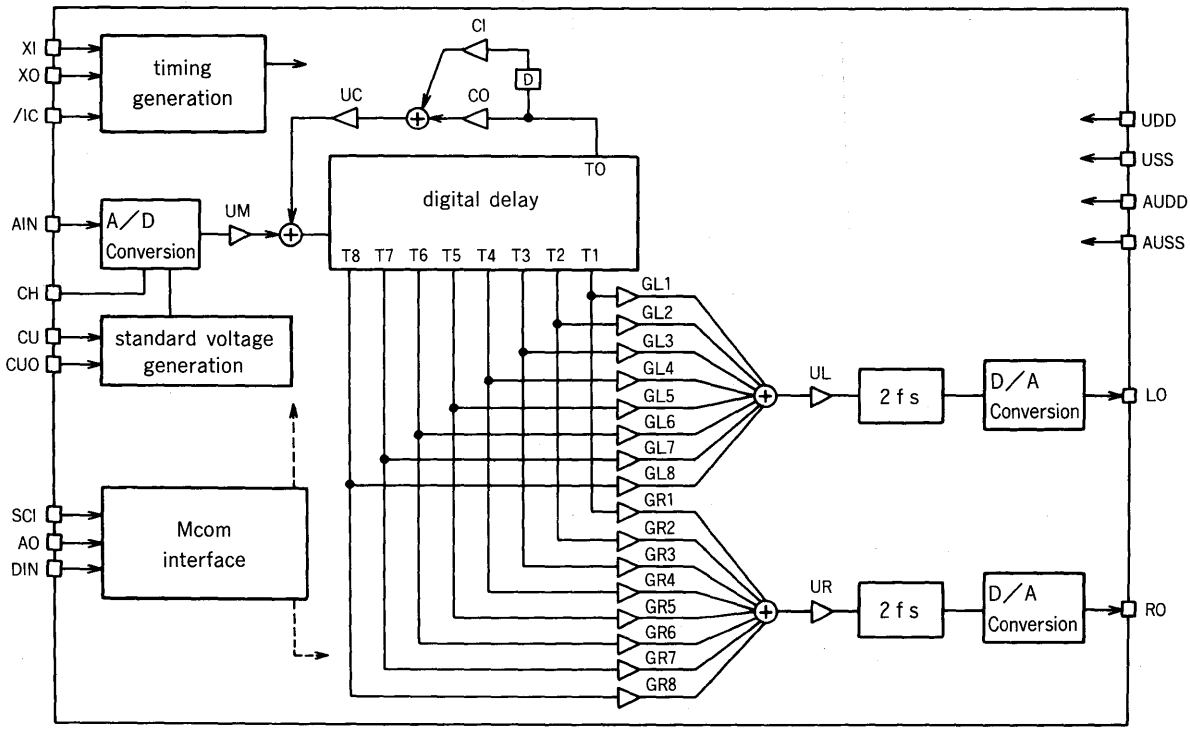
※1: Applicable to input terminals except XI

※2: Applicable to XI terminal

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



SOUND SIGNAL PROCESSOR

Pitch Changer

YM3408 PTC

■ OUTLINE

YM3408 is a Pitch Changer LSI that lowers the pitch of the input signals in realtime by one octave.

The use of this LSI enables audio signals that are played back at double-speed to be heard at normal pitch.

■ FEATURES

- Corrective processing of non-consecutive points to prevent the generation of "jointed" sounds
- Built-in 12-bit D/A and A/D converters
- 28 KHz sampling frequency (when the Master Clock frequency is 3.58 MHz)
- Use of a 16k-bit SRAM as external memory
- CMOS-processed low power consumption
- 28 pin plastic DIP (Dual Inline Package)
- +5V power supply

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

Item	Rated Value	Unit
Input terminal voltage	−0.3~7.0	V
Operating temperature	0~70	°C
Storage temperature	−50~125	°C

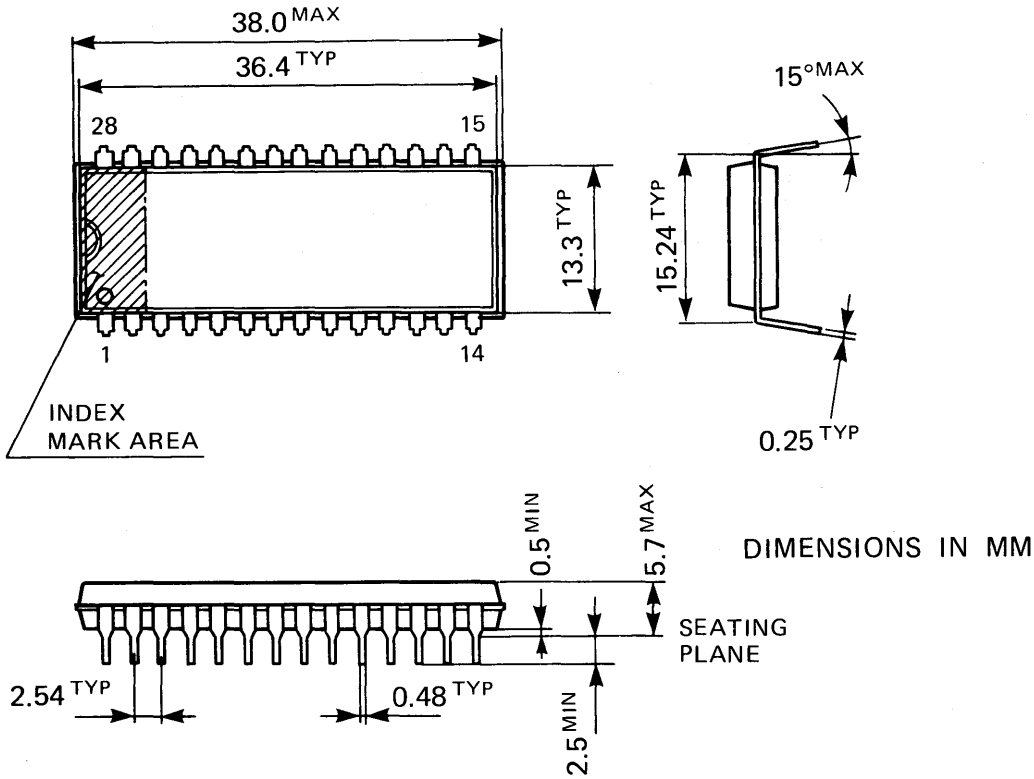
2. Recommended Operating Conditions

Item	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	VCC	4.75	5.0	5.25	V
	GND, AGND	0	0	0	V

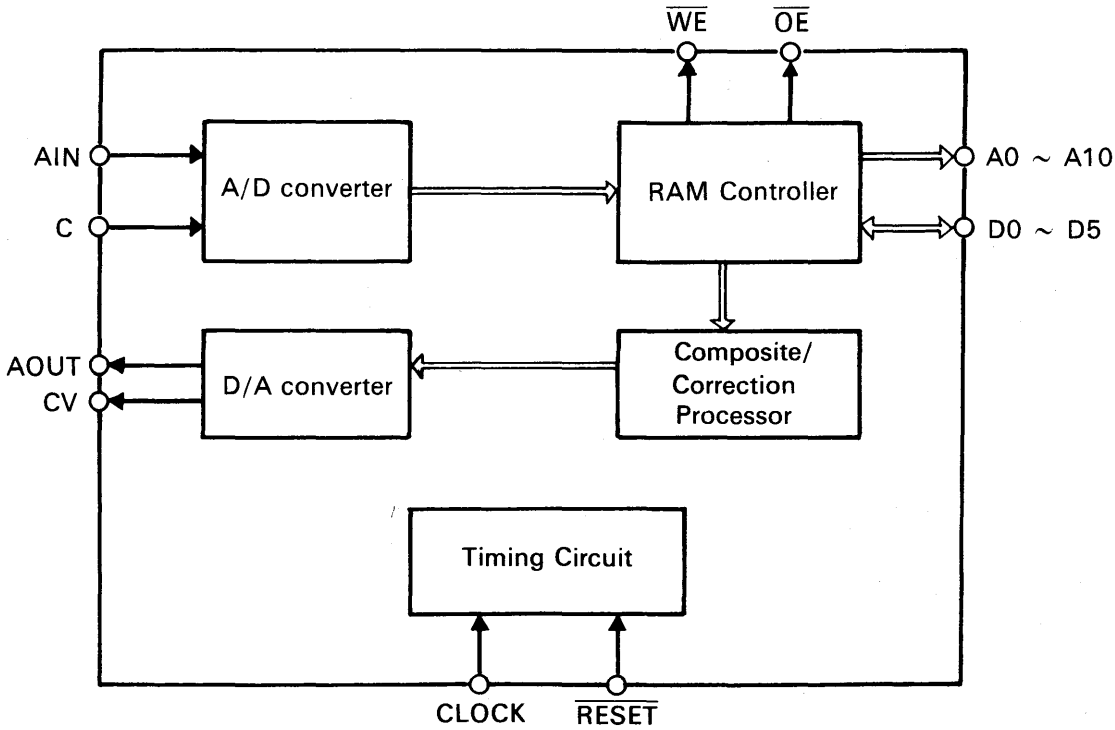
3. DC Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Low-level input voltage	V_{IL}				0.8	V
High-level input voltage	V_{IH}		2.0			V
Low-level clock input voltage	V_{CL}				0.8	V
High-level clock input voltage	V_{CH}		2.0			V
Input leak current	I_{IL}	V_{IN}=1~5V	−10		10	μA
Low-level output voltage	V_{OL}	I_{OL}=2mA			0.4	V
High-level output voltage	V_{OH}	I_{OH}=100μA	4.0			V
Analog input voltage	V_{IA}	AIN	1.0		4.0	V
Analog output voltage	V_{OA}	AOUT max. magnitude			3.0	Vp-p
DC output offset		CV		2.5		V
Supply current	I_{CC}				5.0	mA
Input capacity	C_I	f=1MHz			10	pF
Output capacity	C_O				10	pF

■ OUTLINE DIMENSIONS



■ BLOCK DIAGRAM



SOUND SIGNAL PROCESSOR

Digital Compressor

YM3412B COMP

■OUTLINE

Wide dynamic range is one of the most significant features of digital audio signals. However, this feature can be a disadvantage of the total system, when digital audio is used with analog system having limited dynamic range such as car CD, portable CD or headphone CD, or when recording CD to a cassette tape.

There is also a problem when part of a low volume signal is lost during attenuation of digital output or during digital volume processing.

The latest yamaha digital sound processing technology has been used to create an LSI chip with a compressor function (which includes a volume processing option) that will automatically respond to the input level and compress the dynamic range of the digital audio signal.

■FEATURES

- An input signal emulation compressor based on digital sound processing technology. Automatic emulation of low or high volume input signals, based on a unique input signal level detection circuit.
- Capable to cope with MSB first 2's complementary input signals with fs at 32 KHz, 44.1 KHz, 48 KHz or double fs.
- Capability in 2 modes:

<Mode 1> (Compressor)

Four different compression ratios can be employed, determined by the setting of the compression switching terminals (SEL0,SEL1).

Compression ratios vary when detected input level is between −54dB and −18dB. Below −54dB, the input and output values are equal, and beyond −18dB, attenuation is carried out.

DCR (DCR is the dynamic compression ratio when the detected input level is between −54dB and −18dB.)

1. 1/1 Input and output levels are equal.
2. 3/4 When the detected input level is over −18dB, the reduced rate is fixed at −9dB.
3. 2/3 When the detected input level is over −18dB, the reduced rate is fixed at −12dB.
4. 1/2 When the detected input level is over −18dB, the reduced rate is fixed at −18dB.

<Mode 2> (Digital Attenuator with compressing)

When an external microprocessor is used to input volume data (8bit, attenuation at 0.375dB), attenuation of sound of volume is carried out while still maintaining the compressor function. (During initial clear, muting condition is set with the volume value "∞".)

- CMOS, 18 pin , plastic DIP, +5V power supply

■ELECTRICAL CHARACTERISTICS

(1) Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit
Supply voltage	V_{DD}	−3.0	+7.0	V
Input voltage	V_I	−0.3	V_{DD}+0.5	V
Ambient operating temperature	T_{OP}	0	+70	℃
Storage temperature	T_{STG}	−50	+125	℃

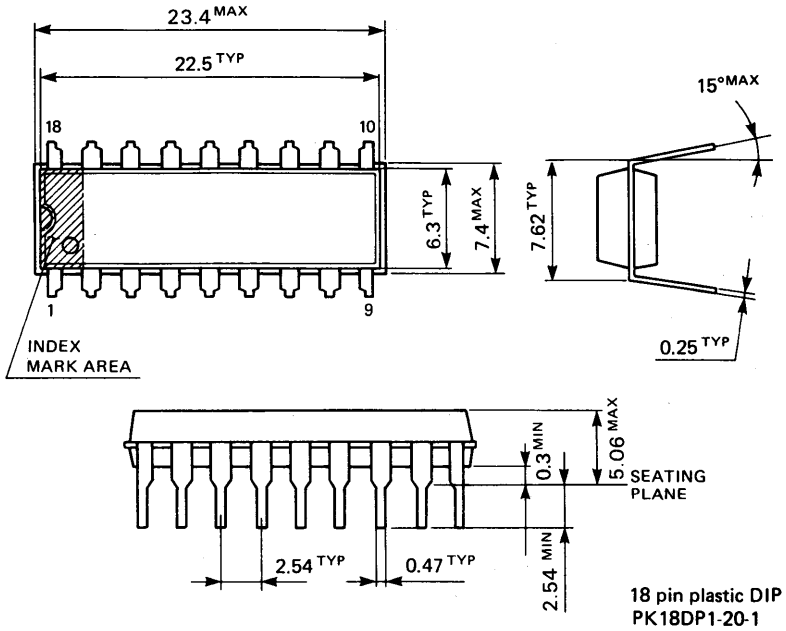
(2) Recommended Operating Conditions

Item	Sybol	Min	Typ	Max	Unit
Supply voltage	V_{DD}	4.75	5.00	5.25	V
Ambient operating temperature	T_{Op}	0	25	+70	℃

(3) DC Characteristics

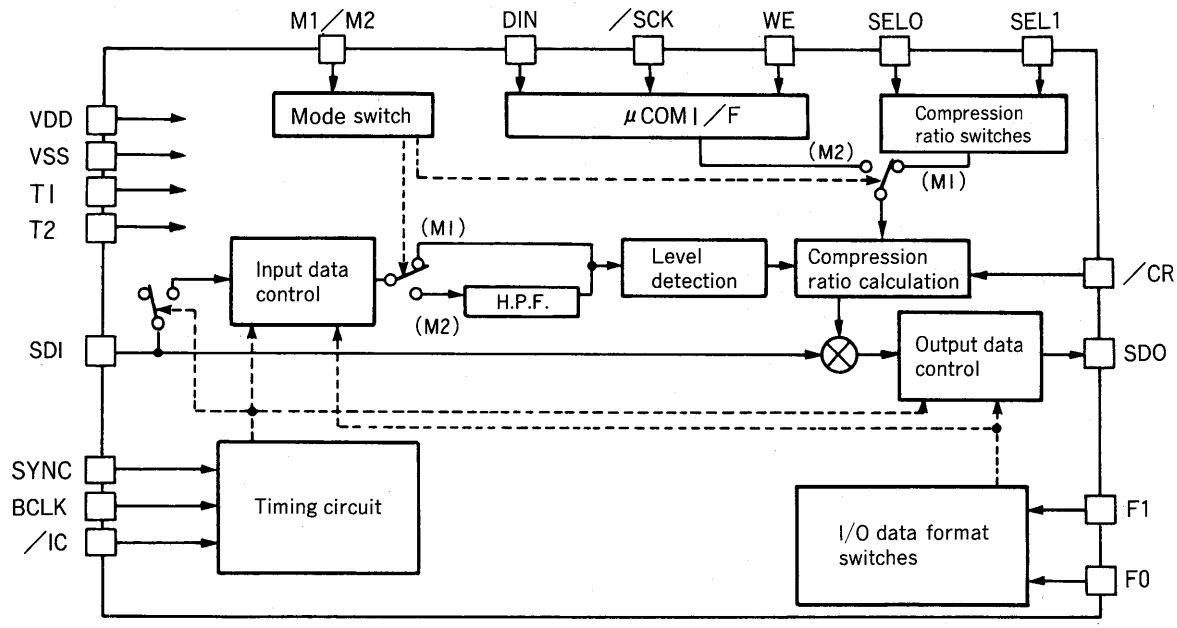
Item	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage	I_{DD}	V_{DD}=5V				mA
High output voltage	V_{OH}	I_{OH}=20μA	4.0			V
Low output voltage	V_{OL}	I I_{OL}=1mA			0.4	V
High input voltage 1	V_{IH1}		3.5			V
Low input voltage 1	V_{IL1}				1.5	V
High input voltage 2	V_{IH2}		2.0			V
Low input voltage 2	V_{IL2}				0.8	V
Input current leakage	I_{IL}		−10		10	mA

■ OUTLINE DIMENSIONS



18 pin plastic DIP
PK18DP1-20-1

■ BLOCK DIAGRAM



Recommendation for surface-mount LSI

1. When using Soldering Iron;

   Temperature at the device lead part shall be controlled as 260 ℃ per 10 seconds or below.

2. Using Flow Soldering / Solder Dip;

   It is not appropriate to use this method for QFP devices and some of SOP devices.

3. By Infra-Red Reflow

   - To avoid character-deterioration or package crack by the absorbed moisture, PRE-BAKE shall be applied at the condition of 125 ℃ for 8 to 24 hours.
   - To avoid damaging local heating, Up-down heating is recommended.
   - Temperatures of the surface of package and PCB shall be below 235 ℃ and less than 10 seconds.
   - Please refer to Figure 1 for recommended Temperature Profile.

4. By VPS (Vapor Phase) Reflow

   - To apply PRE-BAKE as explaned in 3.
   - Ambient Temperature shall be;

     Max. 215 ℃, less than 30 seconds.
   - Please refer to Figure 2 for Recommended Temperature Profile.

INFRA-RED REFLOW
Recommended Temperature Profile

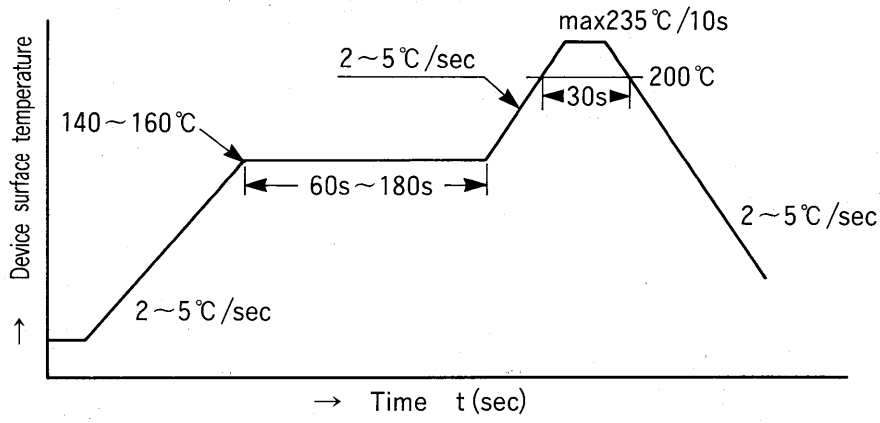


Figure 1

VAPOR PHASE REFLOW (VPS)
Recommended Temperature Profile

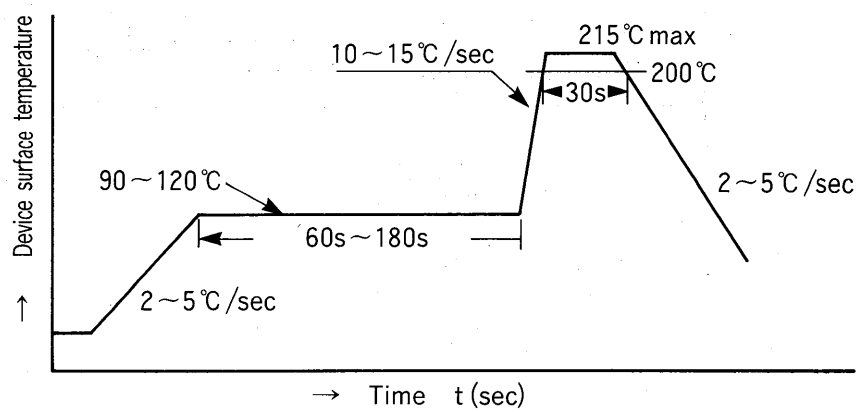


Figure 2

YAMAHA

YAMAHA CORPORATION

The specifications of these products are subject to improvement changes without prior notice.

YAMAHA CORPORATION

Address inquires to:
Electronic System Division

■ Tokyo Office
3-4, Kanda Surugadai. Chiyoda-ku.
Tokyo, 104
Ryumeikan Bldg. 4F
Tel. 03-255-4481 , Fax. 03-255-4488

■ Osaka Office
3-12-9. Minamisenba, Chuo-ku
Osaka-city, Osaka, 542
Shinsaibashi Plaza Bldg. 4F
Tel. 06-252-7980 , Fax. 06-252-5615

■ HEAD Office
203, Matsunokijima, Toyooka-mura,
Iwata-gun, Shizuoka-ken, 438-01
Electronic Equipment business section
Tel. 053962-4918
Fax. 053962-5054

■ YAMAHA Systems Technology
3051 North First Street
San Jose, CA 95134
Tel. 408-433-5260
Fax. 408-433-5230

No.YTK-001E 1989. 9