M62416P/FP

3-ELEMENT GRAPHIC EQUALIZER WITH MICROCOMPUTER INTERFACE

DESCRIPTION

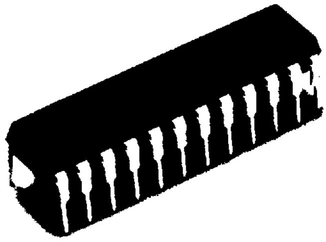
The M62416 is a tone controller IC.

The IC has a resonance circuitry and is, with 8-bit serial data sent from a microcomputer, capable of performing 2 channel, 3 band tone control.

It is best suited to preset tone control applications.

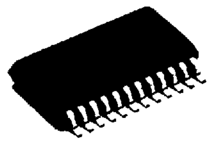
FEATURES

- Housed in 24-pin shrink package (SSOP)
- Built-in microcomputer interface circuit controlled by 8-bit serial data
- Built-in 2 channel, 3 band tone control.
- Low noise: V_{NO} = 10 μV_{rms} (typ.) <IHF-A>
- Low distortion factor: THD = 0.03% (typ.)



Outline 24P4D (P)

2.54mm pitch 300mil DIP
(6.3mm×29.2mm×3.3mm)



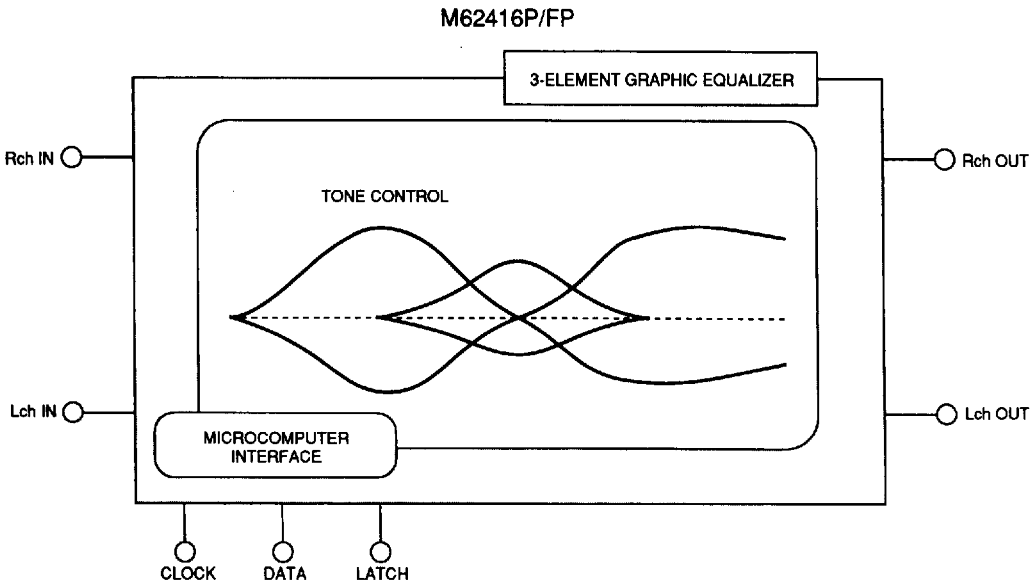
Outline 24P2Q-A (FP)

0.8mm pitch 300mil SSOP
(5.3mm×10.1mm×1.8mm)

RECOMMENDED OPERATING CONDITIONS

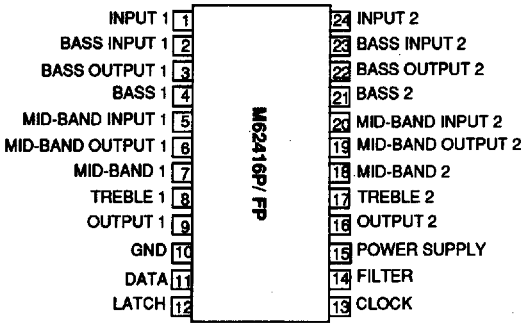
Supply voltage range .... V_{CC} = 6.0 to 12.0 V
Rated supply voltage .... V_{CC} = 7 V

SYSTEM CONFIGURATION



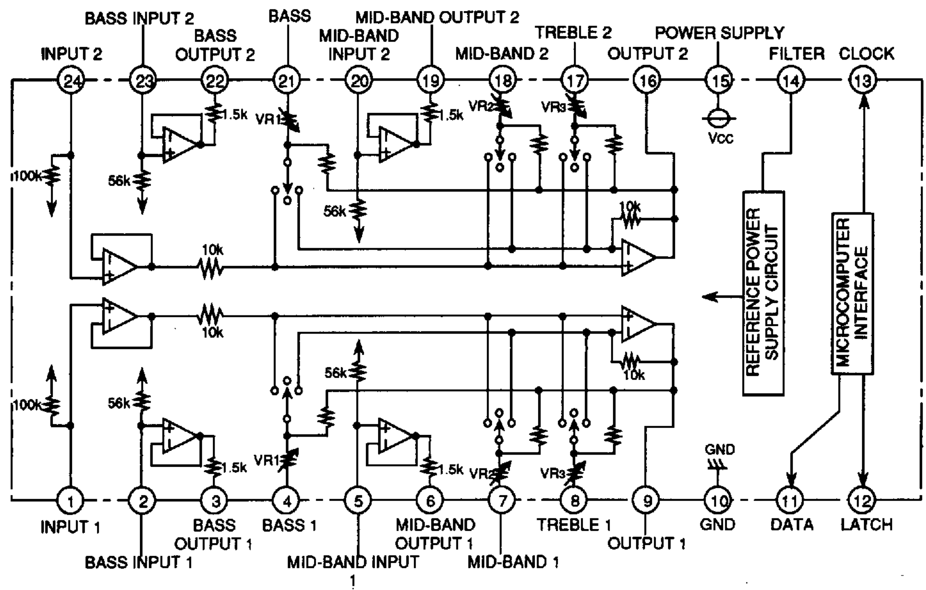
6249826 0022216 532

PIN CONFIGURATION (TOP VIEW)



NC : NO CONNECTION

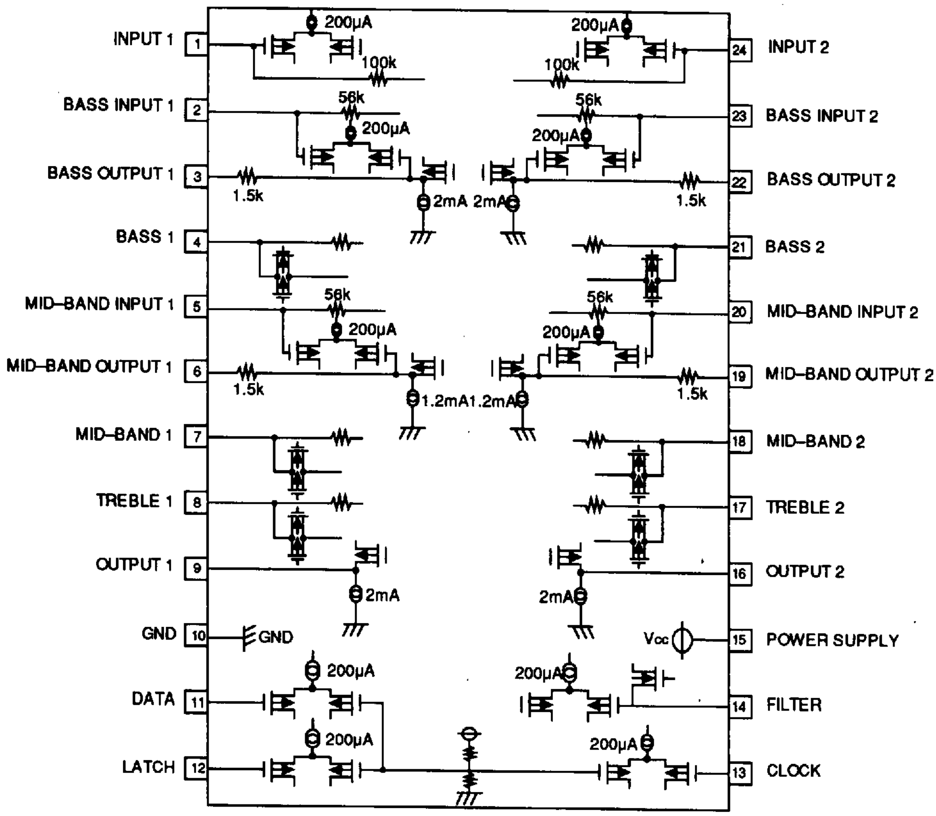
IC INTERNAL BLOCK DIAGRAM



VR1: ±3dB; 22.7k, ±6dB; 8.5k, +9dB; 4k
VR2: ±3dB; 22.7k, ±6dB; 8.5k
VR3: ±3dB; 24.2k, ±6dB; 10k, +9dB; 5.5k

Units Resistance : Ω
Capacitance : F

INPUT/OUTPUT FORM (Design values are indicated in figure.)



Units Resistance : Ω
Capacitance: F

PIN DESCRIPTION

Pin No.	Name	Function
① (㉔)	Input 1 (2)	Ch 1 (2) signal input
② (㉓)	Bass input 1 (2)	Bass resonance amp input
③ (㉒)	Bass output 1 (2)	Bass resonance amp output
④ (㉑)	Bass 1 (2)	Bass gain selection
⑤ (⑳)	Mid-band input 1 (2)	Mid-band resonance amp input
⑥ (⑲)	Mid-band output 1 (2)	Mid-band resonance amp output
⑦ (⑱)	Mid-band 1 (2)	Mid-band gain selection
⑧ (⑰)	Treble 1 (2)	Treble gain selection
⑨ (⑯)	Output 1 (2)	Ch 1 (2) signal output
⑩	GND	Ground
⑪	Data	Input of control data sent from μ-COM to IC Receives data in sync with clock
⑫	Latch	Data latch of serial data sent from μ-COM to IC Operates at falling edges.
⑬	Clock	Clock used to transmit serial data from μ-COM to IC Operates at rising edges.
⑭	Filter	Removal of ripples in power source
⑮	Power Supply	Applies 6 to 12 V (rating: 7 V)

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Ratings	Unit
V_{cc}	Supply voltage	14	V
P_d	Power dissipation	540	mW
k_θ	Thermal derating (Ta≧25℃)	5.4	mW/℃
T_{opr}	Operating temperature range	–20 to 75	°C
T_{stg}	Storage temperature	–55 to 125	°C

ELECTRICAL CHARACTERISTICS (Ta = 25℃, Vcc = 7 V, f = 1 kHz, and flat, unless otherwise noted)

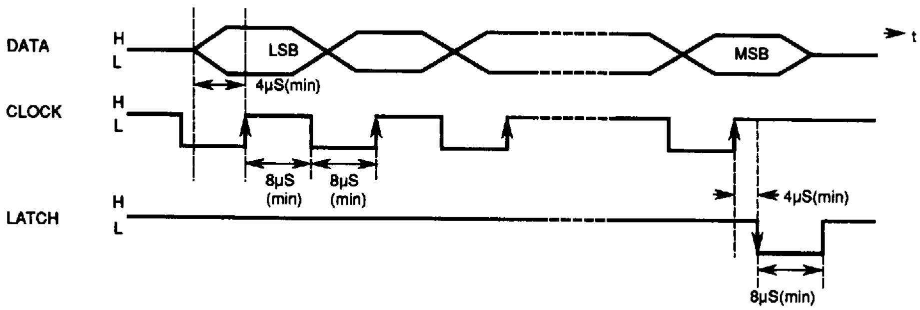
Symbol	Parameter			Test conditions	Limits			Unit
					Min	Typ	Max	
I_{cc}	Circuit current			Quiescent	13	23	33	mA
GV(flat)	Gain				–	0	–	dB
G(Bass)B	Tone	Bass	Boost (max.)		–	9	–	dB
G(Bass)C	Tone	Bass	Cut (max.)		–	–6	–	dB
G(MID)B	Tone	Mid-band	Boost (max.)		–	6	–	dB
G(MID)C	Tone	Mid-band	Cut (max.)		–	–3	–	dB
G(Tre)B	Tone	Treble	Boost (max.)		–	9	–	dB
G(Tre)C	Tone	Treble	Cut (max.)		–	–6	–	dB
Gstep	Tone	Control step			–	3	–	dB
V_{OM}	Maximum output voltage			THD = 1%	1.5	20	–	V_{rms}
THD	Total harmonic distortion			V_O = 0.5V_{rms}	–	0.03	0.3	%
V_{NO}	Output noise voltage			Rg = 10kΩ, filter: IHF-A	–	10	23	μV_{rms}
CS_{ep}	Channel separation			Filter: IHF-A	–	–90	–70	dB

DIGITAL CONTROL SPECIFICATIONS

Data format

	3bit	2bit	3bit	
(MSB)	TREBLE	MID-BAND	BASS	(LSB)

Timing diagram (recommended conditions)



Note: 1. CLOCK operates at rising edges of pulse.
2. LATCH operates at rising edges of pulse.
3. Recommended imput level
"H" level:more than 4V
"L "levelsless than 1V.

DATA SETTING TABLE

Treble

	Data			Gain
	D5	D6	D7	
Boost	H	H	H	9dB
	H	H	L	6dB
	H	L	H	3dB
Flat	L	L	L	0dB
Cut	L	L	H	–3dB
	L	H	L	–6dB

Mid-band

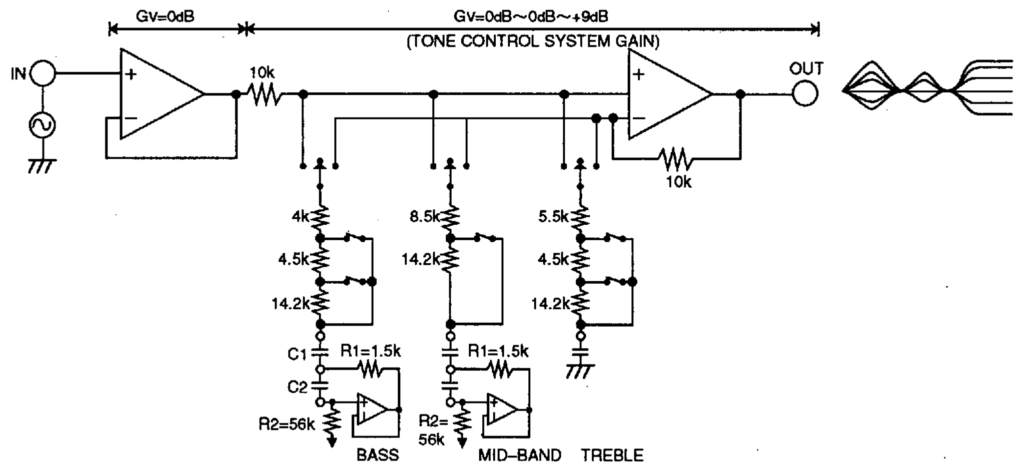
	Data		Gain
	D3	D4	
Boost	H	H	6dB
	H	L	3dB
Flat	L	L	0dB
Cut	L	H	–3dB

Bass

	Data			Gain
	D0	D1	D2	
Boost	H	H	H	9dB
	H	H	L	6dB
	H	L	H	3dB
Flat	L	L	L	0dB
Cut	L	L	H	–3dB
	L	H	L	–6dB

FUNCTION DESCRIPTION

(1) Tone block: Processes main analog signals.



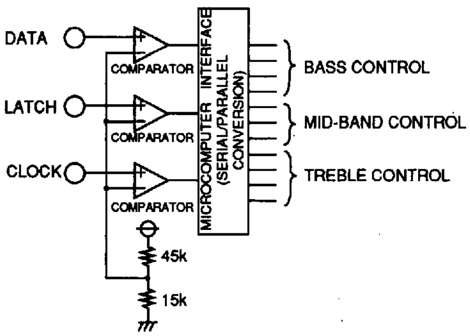
1) Input signals are separated into bass, mid, and treble bands. Resonance circuits (band-pass filters) separate signals into bass and mid bands, while treble is separated by a CR filter. These separated signals are boosted or cut by making selection from internal gain setting resistors.

2) Tone control step.

Bass :	–6dB ~ 0dB ~ 9dB	3dB/step
Mid-band:	–3dB ~ 0dB ~ 6dB	3dB/step
Treble:	–6dB ~ 0dB ~ 9dB	3dB/step

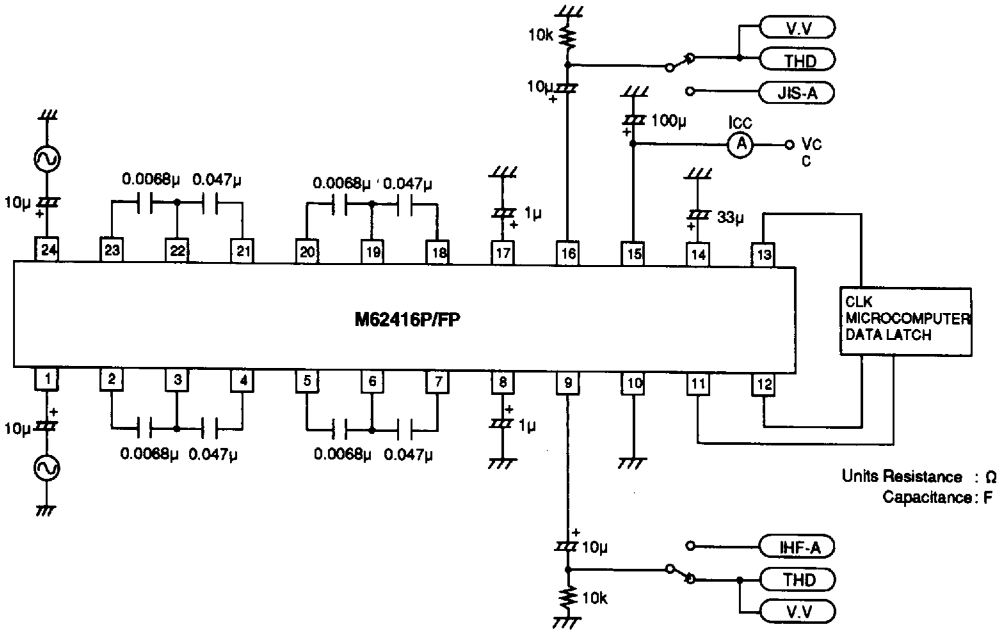
3) Gain control in each band is performed by means of serial data sent from a microcomputer.

(2) Control block: Processes data transmitted from a microcomputer to control the gain in each band.



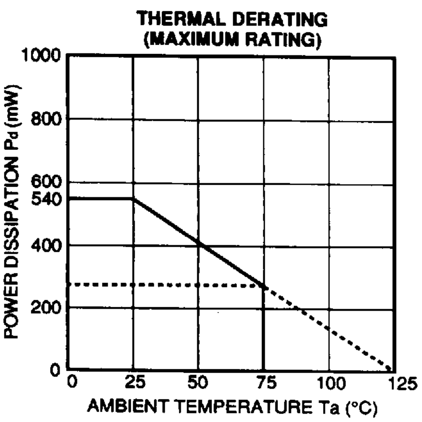
1) Send initialization data at power up, because the internal logic is unstable at power up.
2) 8-bit serial data is used for control by microcomputer. For data settings, see Digital Control Specifications on page 6.

TEST CIRCUIT



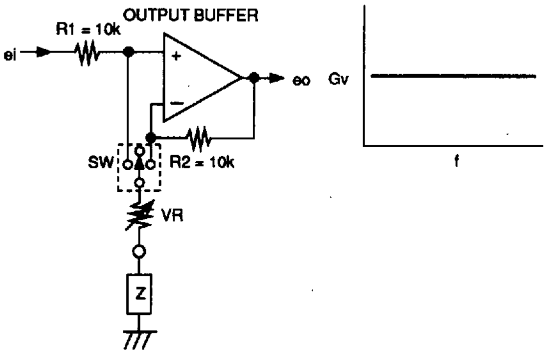
Units Resistance : Ω
Capacitance : F

TYPICAL CHARACTERISTICS



(1) Flat boost cut

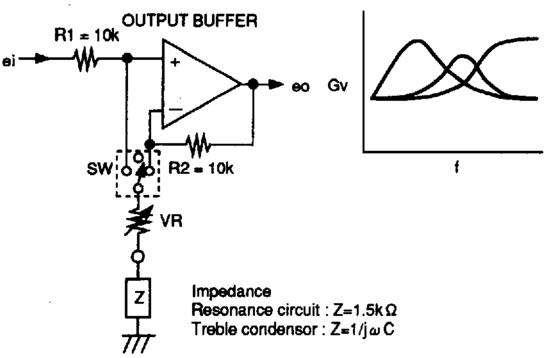
(a) Flat



SW is center position, the frequency characteristics will be level regardless of the resonance circuit.

●Z is an impedance in the resonance circuit.

(b) Boost



When the SW is in boost position, the resonance circuit is connected to the NF loop of the output buffer amplifier.

The gain Av is

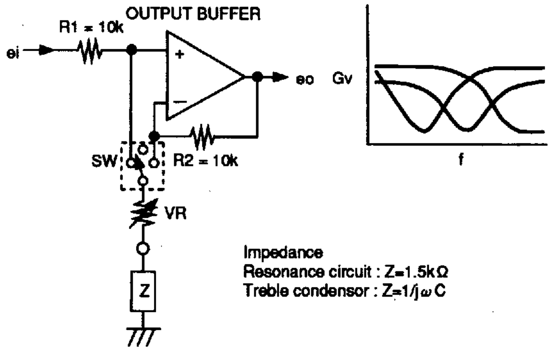
$$Av = \frac{R2 + Z + VR}{Z + VR}$$

The output voltage eo is

$$eo = Av \cdot ei = \frac{R2 + Z + VR}{Z + VR} ei$$

When Z is smallest, the gain in resonance is the greatest, and the optional frequency is then boosted.

(c) Cut



When the SW is in cut position, the resonance circuit is connected to the input side of the output buffer amplifier.

The gain Av is

$$ei = \frac{VR + Z}{R1 + VR + z} ei \quad AV = 1 \text{ and}$$

The output voltage eo is

$$eo = Av \cdot ei = \frac{VR + Z}{R1 + VR + z} ei$$

When Z is smallest, the gain in resonance is the greatest, and the optional frequency is then cut.

(2) Resonance circuit

The simulated inductor circuit converts L in the R, L, C serial resonance circuit into a CR pin by the buffer functions of active pins such as resisters. Operational amplifiers, works in a almost the same way as the R, L, C serial resonance circuit.

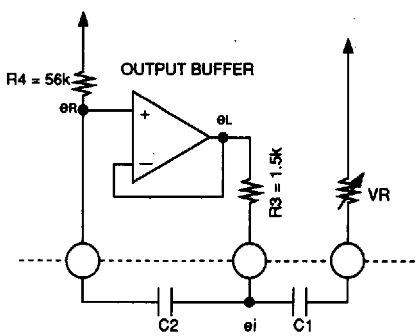


Fig.1 Tone control circuit

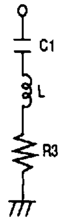


Fig.2 Equivalant circuit

(a) Frequency fo

The L, R, C resonance frequency fo is

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$ ---------------------------------- Equation No.1

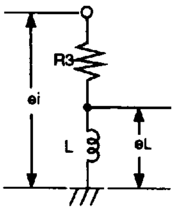


Fig.3

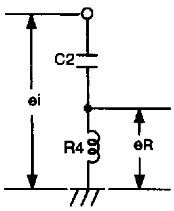


Fig.4

When the voltage ei is supplied to resonance circuit as shown in Fig.3

$$e_L = \frac{j\omega L}{R3 + j\omega L} e_i$$

if ei is then supplied to the pins C1, R4 as shown in Fig.4

$$e_R = \frac{j\omega C2 \cdot R4}{1 + j\omega C2 \cdot R4} e_i = \frac{j\omega C2 \cdot R3 \cdot R4}{R3 + j\omega C2 \cdot R3 \cdot R4}$$

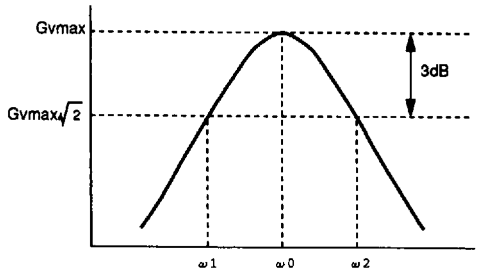
$L = C2 \cdot R3 \cdot R4$ When $e_L = e_R$ ----------------- Equation No.2

If e_R is replaced by e_L and L serial circuit, R3 and C1 are automatically connected in order to keep the value of e_R stable, a buffer amplifier should be used. The buffer amplifier is equivalent to an impedance. By equations No.1 and No.2, the resonance frequency, fo is

$$f_o = \frac{1}{2\pi\sqrt{C1 \cdot C2 \cdot R3 \cdot R4}}$$

(b) Shape of resonance

About Shape of resonance, Q is defined by the ratio of ωo($\omega o = 2\pi$ fo) and the frequency band width $\omega 2 - \omega 1$, (Gmax/$\sqrt{2}$)

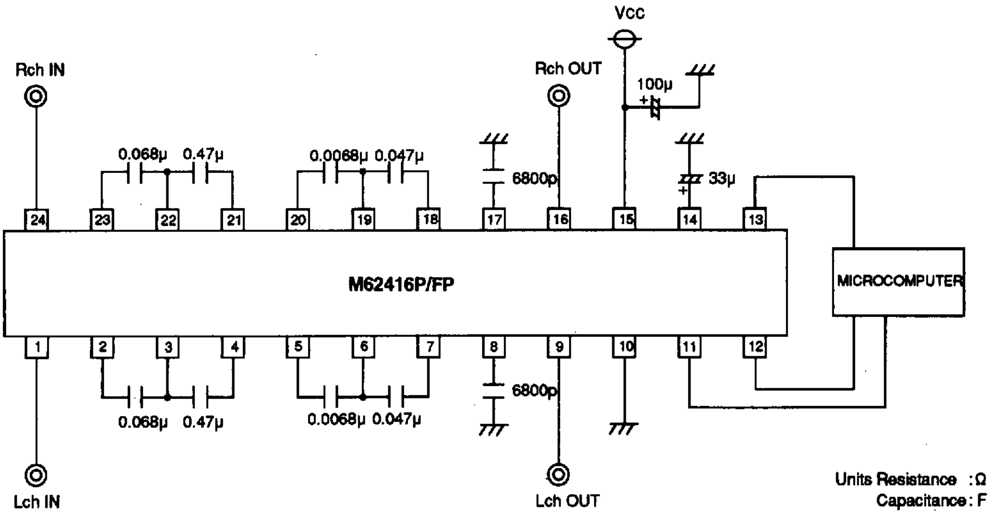


The value of Q is found by the following equation ;

$$Q = \sqrt{\frac{C2 \cdot R4}{C1 \cdot R3}}$$

The greater the value of Q the narrower the frequency band width and vice versa. The M62416FP is composed of R3, R4, so Q is defined by selecting the external condensor.

APPLICATION EXAMPLE



Frequency characteristics