

SANYO**LC8902, 8902Q****Digital Audio Interface Receiver****Overview**

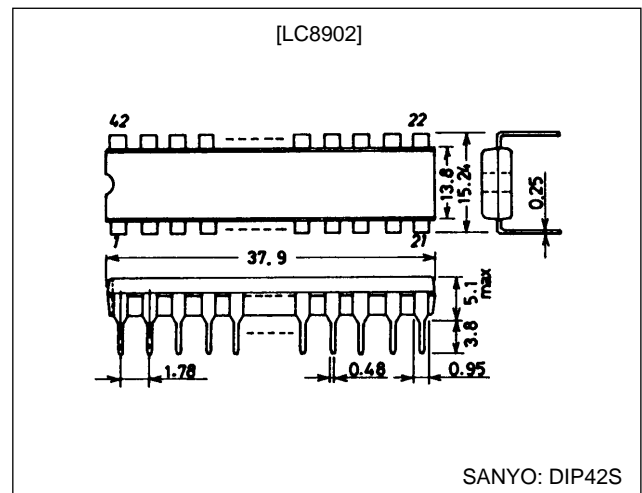
The LC8902 and LC8902Q are receiver LSIs for applications in which data is transmitted between digital audio equipment in the EIAJ format. These LSIs synchronize with the input signal and demodulate that signal to a regular format signal.

Features

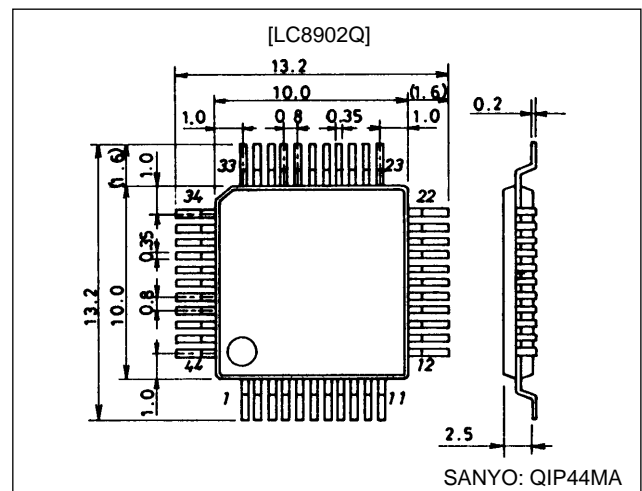
- Built-in PLL circuit synchronizes with the input EIAJ format signal.
- Microcomputer interface receives mode settings and outputs fs codes, copy information, and category codes.
- Supports both 384 fs and 512 fs system clocks (selectable) and provides 256 fs, 128 fs, BCLK and LRCK clock outputs.
- Can operate in either digital source mode or analog source mode.
- User bit CD subcode interface
- DIP42S and QIP44M packages
- Si gate CMOS process, single 5 V power supply

Package Dimensions

unit: mm

3025B-DIP42S

unit: mm

3148-QFP44MA

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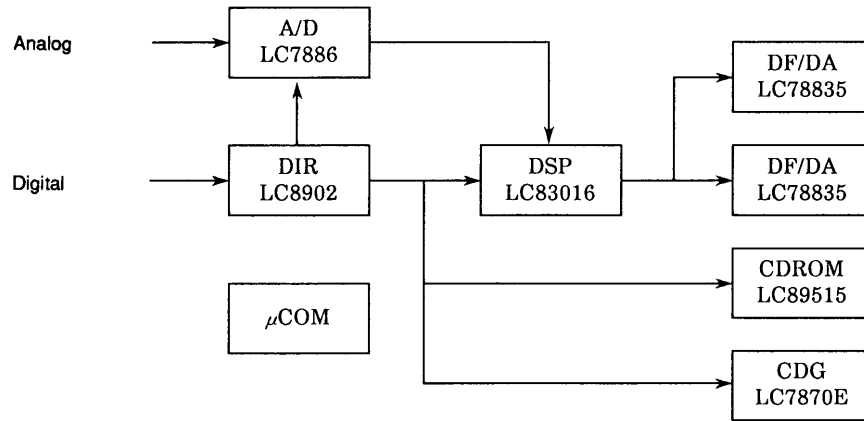
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Application Usage Overview Diagram

When both digital source mode and analog source mode are used

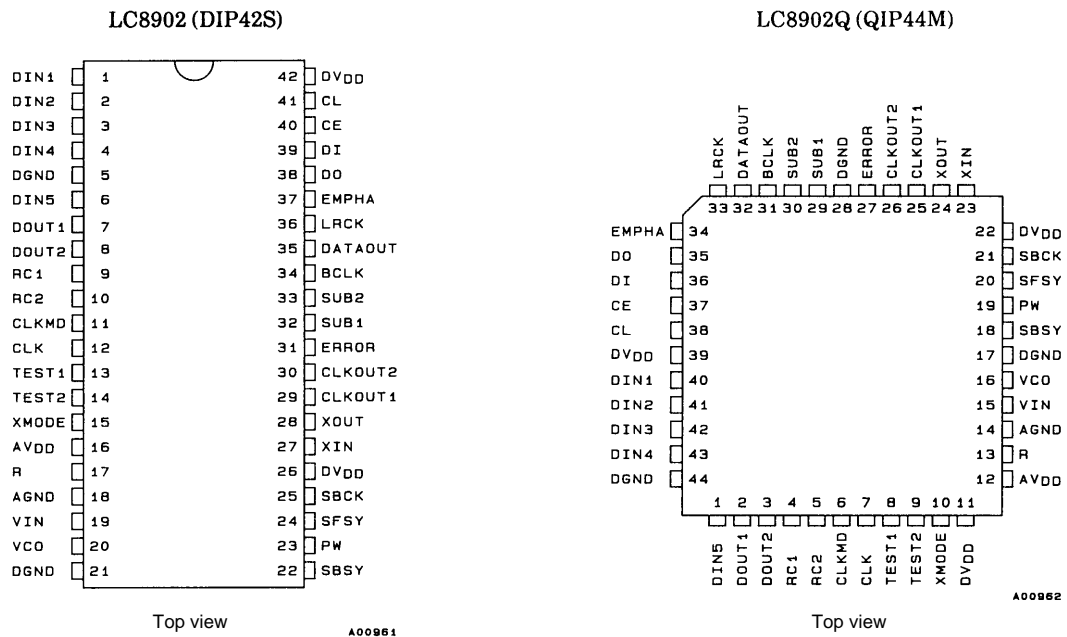
Digital source mode: EIAJ CP-1201 format data reception mode

Analog source mode: Analog data is received and converted to digital for signal processing.



This figure shows an example of a structure using the LC8902/Q. In analog source mode the only function of the LC8902/Q is to provide control clocks.

Pin Assignments



Specifications

Absolute Maximum Ratings at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|------------------------|------------------------------------|------------|-------------------------------|------|
| Maximum supply voltage | V _{DD} max | | -0.3 to +7.0 | V |
| Maximum I/O voltages | V _I -V _O max | | -0.3 to V _{DD} + 0.3 | V |
| Operating temperature | T _{opr} | | -30 to +75 | °C |
| Storage temperature | T _{stg} | | -55 to +125 | °C |

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Allowable Operating Ranges

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|-----------------------|-----------|------------|-----|-----|-----|------|
| Supply voltage | V_{DD} | | 4.5 | 5.0 | 5.5 | V |
| Operating temperature | T_{opg} | | -30 | | +75 | °C |

DC Characteristics at $T_a = -30$ to $+75^\circ\text{C}$, $V_{DD} = 4.5$ to 5.5 V

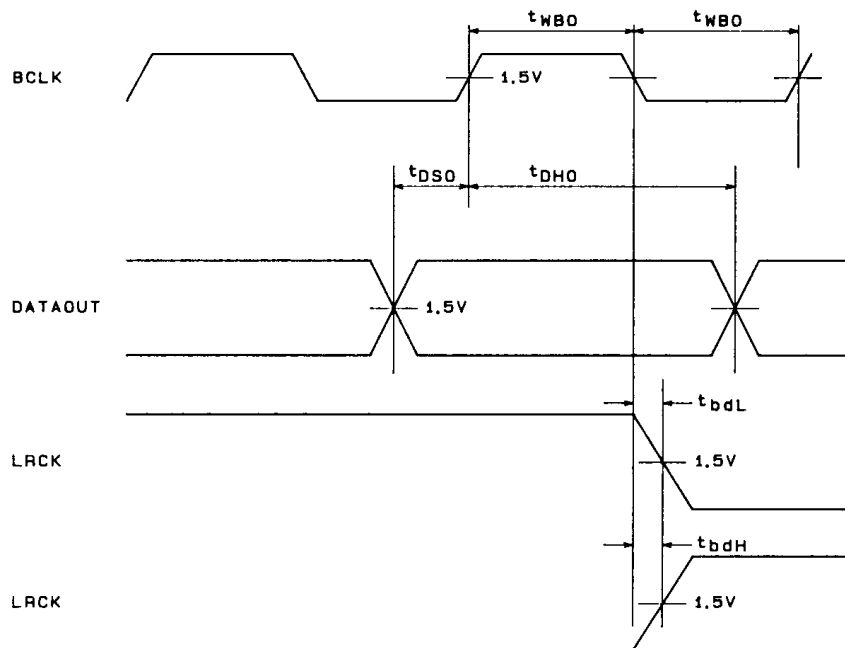
| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---------------------------|-----------|---------------------------|-----------------|-----|-----------------|------|
| Input high level voltage | V_{IH1} | *1 | 2.2 | | $V_{DD} + 0.3$ | V |
| Input low level voltage | V_{IL1} | *1 | -0.3 | | +0.8 | V |
| Input high level voltage | V_{IH2} | *2 | $0.7 V_{DD}$ | | $V_{DD} + 0.3$ | V |
| Input low level voltage | V_{IL2} | *2 | -0.3 | | $+0.3 V_{DD}$ | V |
| Input high level voltage | V_{IH3} | *3 | $0.8 V_{DD}$ | | $V_{DD} + 0.3$ | V |
| Input low level voltage | V_{IL3} | *3 | -0.3 | | $+0.2 V_{DD}$ | V |
| Output high level voltage | V_{OH} | $I_{OH} = -1 \mu\text{A}$ | $V_{DD} - 0.05$ | | | V |
| Output low level voltage | V_{OL} | $I_{OL} = 1 \mu\text{A}$ | | | $V_{SS} + 0.05$ | V |
| Current drain | I_{DD} | *4 | 10 | 20 | 30 | mA |
| Input amplitude | V_{PP} | *5 | 0.4 | | $V_{DD} + 0.3$ | V |

- Note: 1. Input pins other than data input pins DIN1, DIN2, DIN3, DIN4 and XMODE. TTL compatible.
 2. The XIN pin. CMOS compatible.
 3. The XMODE and RC1 pins. CMOS Schmitt inputs.
 4. At $T_a = 25^\circ\text{C}$, $V_{DD} = 5.0$ V, and for an input data f_s of 48 kHz.
 5. The condition prior to the capacitors on the DIN1, DIN2, DIN3 and DIN4 input pins.

AC Characteristics at $T_a = -30$ to $+75^\circ\text{C}$, $V_{DD} = 4.5$ to 5.5 V

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|-----------------------|-----------|------------|-----|-----|-----|------|
| Output pulse width | t_{WBO} | *6 | 160 | | | ns |
| Output setup time | t_{DSO} | | 80 | | | ns |
| Output data hold time | t_{DHO} | | 80 | | | ns |
| Output delay (high) | t_{bdH} | | -10 | 0 | +10 | ns |
| Output delay (low) | t_{bdL} | | -10 | 0 | +10 | ns |

- Note: 6. For an input data f_s of 48 kHz, with a 30 pF load capacitance on each pin.



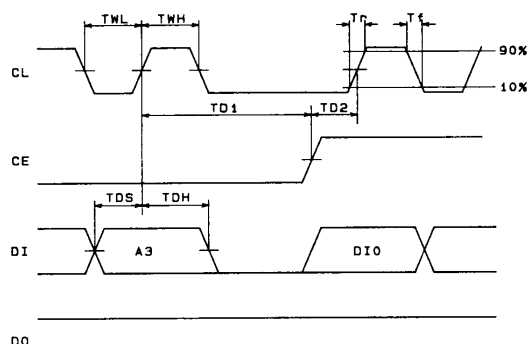
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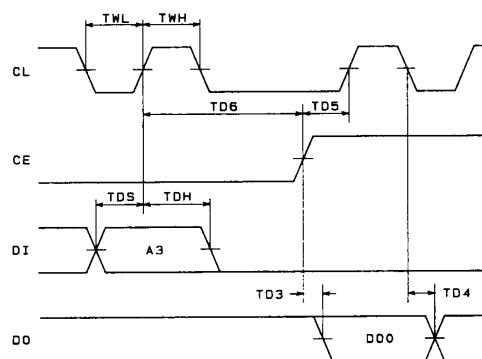
Microcomputer Interface Block AC Characteristics at $T_a = -30$ to $+75^\circ\text{C}$, $V_{DD} = 4.5$ to 5.5 V

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---------------------------|--------|-------------------------------|-----|-----|-----|---------------|
| CL low level pulse width | TWL | | 100 | | | ns |
| CL high level pulse width | TWH | | 100 | | | ns |
| Data setup time | TDS | | 50 | | | ns |
| Data hold time | TDH | | 50 | | | ns |
| CL rise time | T_r | CL, CE, DI | | | 30 | ns |
| CL fall time | T_f | CL, CE, DI | | | 30 | ns |
| CE delay time | TD1 | | 1.0 | | | μs |
| CL delay time | TD2 | | 50 | | | ns |
| Data delay time | TD3 | With a 30 pF load capacitance | | | 25 | ns |
| CL, data delay time | TD4 | With a 30 pF load capacitance | | | 50 | ns |
| CL delay time | TD5 | | 100 | | | ns |
| CL, CE delay time | TD6 | | 1.0 | | | μs |

Input



Output

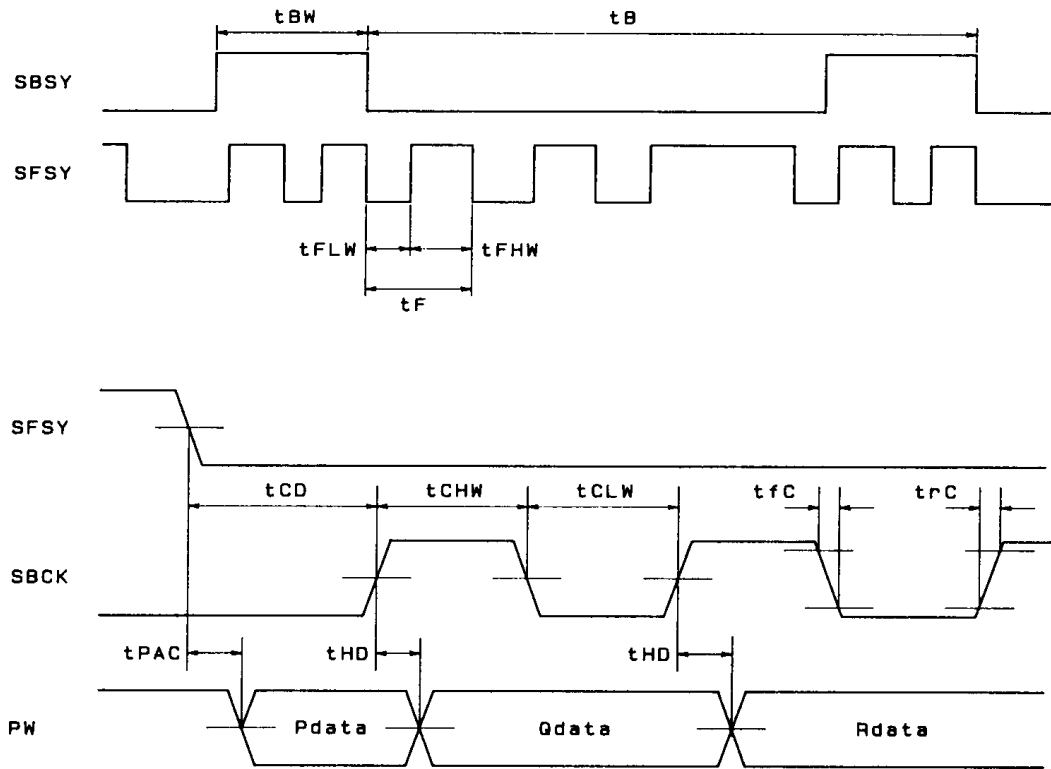


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CD Subcode Interface Block AC Characteristics at $T_a = -30$ to $+75^\circ\text{C}$, $V_{DD} = 4.5$ to 5.5 V

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|-----------------------------|--------|------------|------|------|------|---------------|
| SBSY block frequency | tB | | 12.0 | 13.3 | 14.7 | ms |
| SBSY pulse width | tBW | *7 | 110 | | | μs |
| SFSY frame frequency | tF | *8 | 90 | 136 | 165 | μs |
| SFSY high level pulse width | tFHW | | 4 | | | μs |
| SFSY low level pulse width | tFLW | | 1.5 | | | μs |
| SBCK high level pulse width | tCHW | *9 | 2.0 | 4.0 | 5.0 | μs |
| SBCK low level pulse width | tCLW | *9 | 2.0 | 4.0 | 5.0 | μs |
| SBCK rise time | trC | | | | 30 | ns |
| SBCK fall time | tfC | | | | 30 | ns |
| SBCK delay time | tCD | *9 | 10 | 20 | 30 | μs |
| P data access | tPAC | | | 3 | 10 | μs |
| Data hold time | tHD | | 0 | | | μs |

Note: Assumes that the load capacitance on each output pin is 30 pF.



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The LC8902/Q uses the subcode synchronization word and the start bit in the user bits for subcode interface system timing extraction. Therefore, SBSY and SFSY change depending on that timing. Keep the following notes on user bit transfer in mind when using the values of tBW, tF, tCHW and tCD within the specifications described above. Basically, user bit transfers must follow the table shown here.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
|-----|---|-----|-----|-----|-----|-----|-----|-----|---|----|----|----|-----------------------|
| S0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Subcode sync word*7,8 |
| S1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| S2 | 1 | Q2 | R2 | S2 | T2 | U2 | V2 | W2 | 0 | 0 | 0 | 0 | |
| S3 | 1 | Q3 | R3 | S3 | T3 | U3 | V3 | W3 | 0 | 0 | 0 | 0 | |
| : | : | : | : | : | : | : | : | : | : | : | : | : | |
| : | : | : | : | : | : | : | : | : | : | : | : | : | |
| S97 | 1 | Q97 | R97 | S97 | T97 | U97 | V97 | W97 | 0 | 0 | 0 | 0 | |
| S0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Subcode sync word*7,8 |
| S1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| S2 | 1 | Q2 | R2 | S2 | T2 | U2 | V2 | W2 | 0 | 0 | 0 | 0 | Word length*8,9 |
| : | : | : | : | : | : | : | : | : | : | : | : | : | |

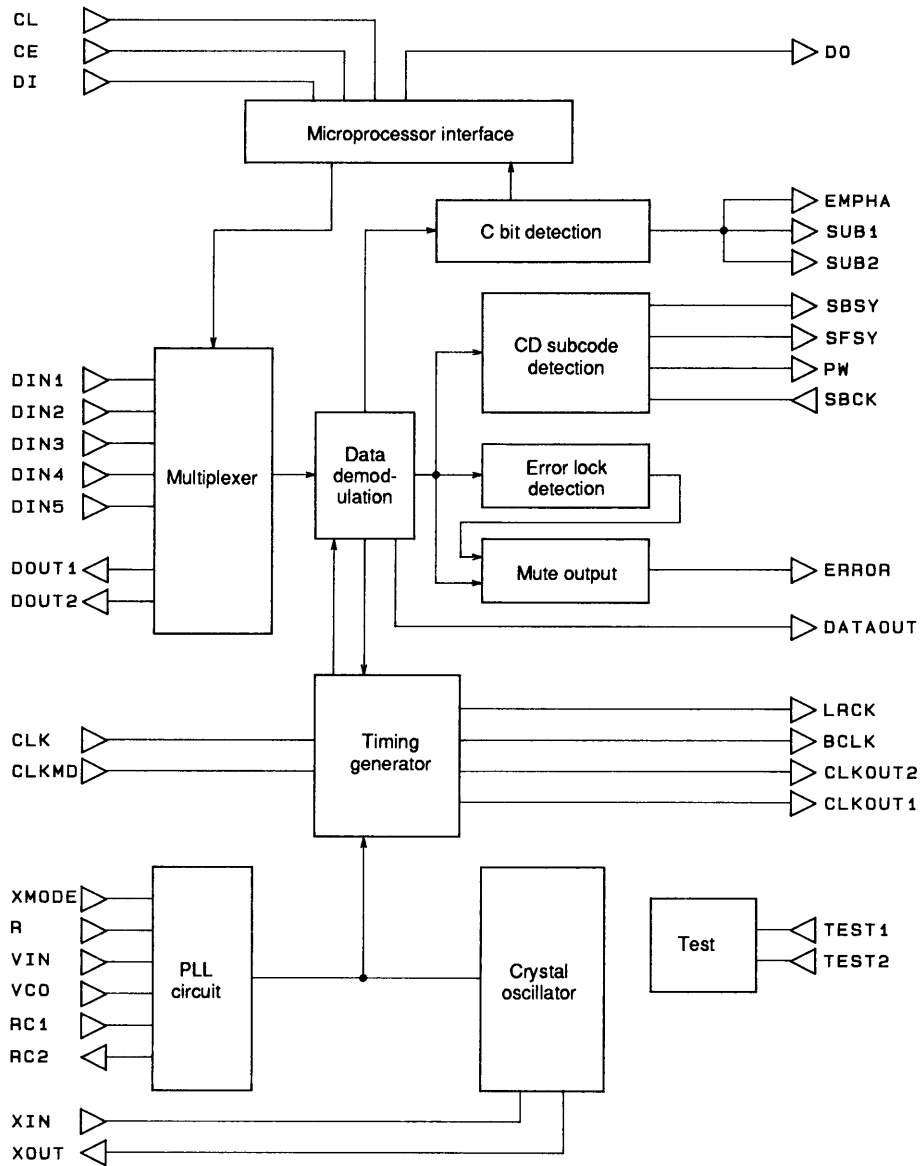
- Note: 7. Subcode synchronization is taken as a block synchronization section (the start of a block) when a minimum of 22 consecutive data bits are zero.
 8. The frame sync signal S0 period is 90.7 μs. The S1 period also has a minimum value of 90.7 μs (when there are 22 consecutive zero data bits), depending on the subcode sync word period.
 9. When the shortest user data word length is used, the SBCK signal delay (tHD) and pulse widths (tCHW and tCLW) must be set at or below their typical values.

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Pin Functions

| Pin No. | | Symbol | I/O | Function |
|---------|-----|------------------|-----|---|
| QIP | DIP | | | |
| 1 | 6 | DIN5 | I | Data input. There is no built-in amplifier on this pin. |
| 2 | 7 | DOUT1 | O | Data outputs |
| 3 | 8 | DOUT2 | O | |
| 4 | 9 | RC1 | I | RC oscillator input This circuit generates a clock used to detect incorrect PLL locking and to reset the PLL system. |
| 5 | 10 | RC2 | O | RC oscillator output This pin outputs a clock with a frequency of about 40 kHz when the component values specified in the sample application circuit are used. |
| 6 | 11 | CLKMD | I | CLKOUT2 output clock switching: Low = 256 fs, high = 128 fs |
| 7 | 12 | CLK | I | Clock mode switching: Low = 384 fs, high = 512 fs |
| 8 | 13 | TEST1 | I | Test pin (Should be tied low in normal operation.) |
| 9 | 14 | TEST2 | I | |
| 10 | 15 | XMODE | I | Used to start system operation after power is applied. |
| 11 | — | DV _{DD} | | Digital power supply |
| 12 | 16 | AV _{DD} | | Analog power supply |
| 13 | 17 | R | I | VCO oscillator band adjustment |
| 14 | 18 | AGND | | Analog ground |
| 15 | 19 | VIN | I | VCO free-running setting |
| 16 | 20 | VCO | O | PLL low-pass filter |
| 17 | 21 | DGND | | Digital ground |
| 18 | 22 | SBSY | O | Subcode interface block sync signal |
| 19 | 23 | PW | O | Subcode interface data output |
| 20 | 24 | SFSY | O | Subcode interface frame sync signal |
| 21 | 25 | SBCK | I | Subcode interface bit clock input |
| 22 | 26 | DV _{DD} | | Digital power supply |
| 23 | 27 | XIN | I | Crystal oscillator input |
| 24 | 28 | XOUT | O | Crystal oscillator output |
| 25 | 29 | CLK OUT1 | O | Crystal oscillator and VCO clock output |
| 26 | 30 | CLK OUT2 | O | 256 fs and 128 fs clock output |
| 27 | 31 | ERROR | O | Error mute signal output |
| 28 | — | DGND | | Digital ground |
| 29 | 32 | SUB1 | O | Sampling frequency output |
| 30 | 33 | SUB2 | O | |
| 31 | 34 | BCLK | O | Bit clock output |
| 32 | 35 | DATA OUT | O | Audio data output |
| 33 | 36 | LRCK | O | Left/right clock output (High = left, low = right) |
| 34 | 37 | EMPHA | O | High = emphasis on, low = emphasis off. Outputs a low level in analog mode. |
| 35 | 38 | DO | O | Microprocessor interface output |
| 36 | 39 | DI | I | Microprocessor interface input |
| 37 | 40 | CE | I | Microprocessor interface chip enable input |
| 38 | 41 | CL | I | Microprocessor interface clock input |
| 39 | 42 | DV _{DD} | | Digital power supply |
| 40 | 1 | DIN1 | I | Data inputs with built-in amplifiers |
| 41 | 2 | DIN2 | I | |
| 42 | 3 | DIN3 | I | |
| 43 | 4 | DIN4 | I | |
| 44 | 5 | DGND | | Digital ground |

Block Diagram



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Clock Modes

The LC8902/Q CLKOUT1 and CLKOUT2 output clock modes are selected by the CLK and CLKMD pins according to the table.

| CLK | CLK OUT1 |
|-----|---------------------|
| L | 384 fs clock output |
| H | 512 fs clock output |

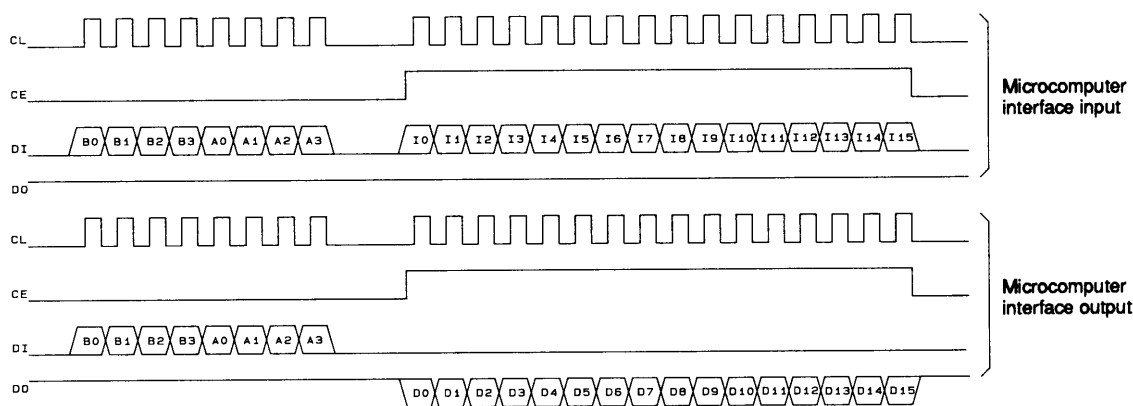
| CLK MD | CLK OUT2 |
|--------|----------------------|
| L | 256 fs clock output* |
| H | 128 fs clock output |

Note: * When the CLK pin is low, the 256 fs clock duty has a high to low ratio of 2:1.

Microcomputer Interface

The microcomputer interface is used for specifying the data input pin, for setting the output data format, and for specifying subcode output, system stop, and analog source mode. The figure shows the interface I/O formats.

Microcomputer Interface Formats



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Address

The bits B0 to A3 in the format figure are the address. There are two addresses allocated to the LC8902/Q, one for input and one for output. The microprocessor must specify the input address to input data and the output address to output data.

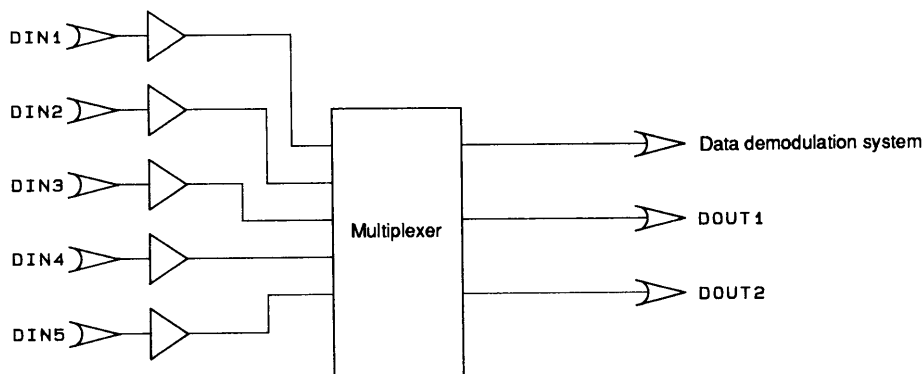
Address Code

| Mode | B0 | B1 | B2 | B3 | A0 | A1 | A2 | A3 |
|-------------|----|----|----|----|----|----|----|----|
| Data input | H | L | H | L | L | H | H | L |
| Data output | L | H | H | L | L | H | H | L |

Microcomputer Interface Input

1. Input pin settings

The DIN1 to DIN4 data input pins have built-in amplifiers and can accept signals with levels of about 400 mVp-p. DIN5 is a special-purpose input pin for optical input.



Data input system

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The data input system multiplexer is controlled by inputs from the microcomputer interface. The table shows the relationship between the code in bits I5 to I13 in the microcomputer interface format and the data demodulation outputs DOUT1 and DOUT2.

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| | | | | | | | | |
|-------------------------|------|------|------|------|------|------|------|------|
| I5 | L | H | L | H | L | H | L | H |
| I6 | L | L | H | H | L | L | H | H |
| I7 | L | L | L | L | H | H | H | H |
| Data demodulation input | DIN1 | DIN2 | DIN3 | DIN4 | DIN5 | XSYS | XSYS | XSYS |

| | | | | | | | | |
|-------|------|------|------|------|------|-----|-----|-----|
| I8 | L | H | L | H | L | H | L | H |
| I9 | L | L | H | H | L | L | H | H |
| I10 | L | L | L | L | H | H | H | H |
| DOUT1 | DIN1 | DIN2 | DIN3 | DIN4 | DIN5 | GND | GND | GND |

| | | | | | | | | |
|-------|------|------|------|------|------|-----|-----|-----|
| I11 | L | H | L | H | L | H | L | H |
| I12 | L | L | H | H | L | L | H | H |
| I13 | L | L | L | L | H | H | H | H |
| DOUT2 | DIN1 | DIN2 | DIN3 | DIN4 | DIN5 | GND | GND | GND |

Note: Setting the data demodulation input code to one of the XSYS settings switches the system clock from the VCO to the crystal oscillator and sets the LC8902/Q to analog source mode. Selecting one of the input pins once again sets the LC8902/Q to digital source mode and PLL operation.

2. Data output mode setting

There are two data output modes: 16-bit MSB first and 20-bit MSB first. These are selected by the bit I14 code.

| | | |
|------------------|------------------|------------------|
| I14 | L | H |
| Data output mode | 16-bit MSB first | 20-bit MSB first |

3. System stop

The operation of both the VCO and the crystal oscillator can be stopped, thus stopping the whole LC8902/Q system, by setting the bit I4 code as shown in the table.

| | | |
|----|------------------|-------------|
| I4 | L | H |
| — | System operation | System stop |

The values of the bits I4 to I14 are all initialized to low immediately after the XMODE pin goes from low to high. Since bits I0 to I3 and I15 are not used, their initial values are undefined.

Microcomputer Interface Output

Bits D0 to D15 in the microcomputer interface output format have the following meanings.

| Bit | Function |
|------------|--|
| D0 | Invalid bit. Always output as a low level. |
| D1 | Indicates the sample frequency. Corresponds to the fs external output pin. |
| D2 | |
| D3 | Indicates the state of the copy flag. High = copy enabled, low = copy protect |
| D4 | Outputs the first bit of the channel status bits. |
| D5 to D12 | These pins output the channel status 8-bit category codes serially. |
| D13 to D15 | Invalid bits. Always output as low levels. |

Interpretation of the D1 and D2 bits

| Sampling frequency | 32 kHz | 44.1 kHz | 48 kHz | #1 |
|--------------------|--------|----------|--------|----|
| D1 | H | L | L | H |
| D2 | H | L | H | L |

Note: 1. The "#1" value indicates either a PLL lock error or analog source mode. In these states the data is cleared and bits D0 and D3 to D15 are all set to low.
2. D1 and D2 are in the "#1" state in the initial values of the codes immediately after the XMODE pin goes from low to high. All other codes are set to low.
3. The interval between one microcomputer data read out operation and the next must be 6 ms or longer.

FS Output Code

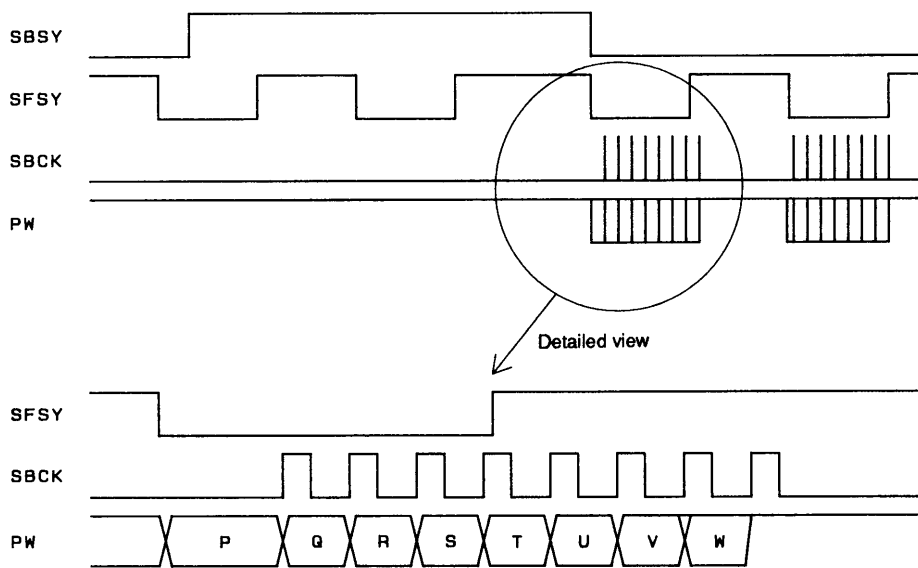
The SUB1 and SUB2 pins indicate the input data sampling frequency.

| Sampling frequency | 32 kHz | 44.1 kHz | 48 kHz | #1 |
|--------------------|--------|----------|--------|----|
| SUB1 | H | L | L | H |
| SUB2 | H | L | H | L |

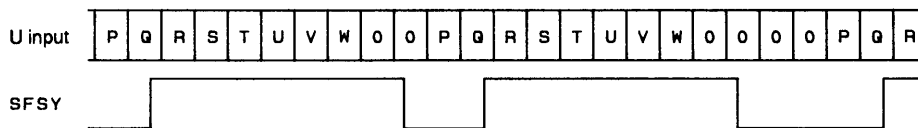
Note: The "#1" values indicates PLL lock error or analog source mode. When SUB1 and SUB2 have these values, the DATAOUT and EMPHA pins will output low levels.

CD Subcode Interface

The LC8902/Q uses the SFSY, SBCK, PW and SBSY pins to output the CD subcode data. This data is the user bits that were transferred according to the CP-1201 interface format and converted to a format that conforms to the CP-2401 interface format. The timing is shown in the figures.



The timing of the rising and falling edges of the SFSY signal is changed according to the timing of the start bits in the input data user bits as shown in the figure.



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Errors

1. ERROR pin: This pin goes high when there are errors in the input data or when the PLL circuit is unlocked. When data demodulation returns to normal, the high level is held for about 200 to 300 ms and then the ERROR pin goes low. This time is inversely proportional to the fs of the input data.
2. Data processing when an error occurs: The table lists the data processing performed when an error occurs.

| Error Type | Audio Output Data | FS Output Code |
|--|-------------------------------------|--|
| Up to 8 consecutive parity errors | Previous data value output | Retained |
| Nine or more consecutive parity errors | Data with the value zero is output. | Retained |
| PLL lock error | Data with the value zero is output. | Data is cleared and the "#1" state is indicated. |

Note: Preamble detection is used to recognize PLL lock errors.

Analog Source Mode

The LC8902/Q switches to analog source in the following two cases.

1. When analog source mode is selected by the data sent over the microcomputer interface
 2. When there is no signal on the input pin selected for data demodulation
- In analog source mode, the clock that runs the whole system is supplied by the crystal oscillator clock and the PLL circuit and data demodulation are stopped. The BCLK, LRCK, CLK, OUT1 and CLKOUT2 clocks are output. The output pins function as follows in analog source mode.

- DOUT1, DOUT2
Data specified through the microcomputer interface is output.
- ERROR
The lock error state high level is output.
- SUB1, SUB2
The "#1" lock error state code is output.
- DATAOUT
The lock error state low level is output.
- EMPHA
The lock error state low level is output.
- Microcomputer interface codes
Input codes: The code values set through the microcomputer interface are retained.
Output codes: Values identical to those for a PLL lock error are output.

Crystal Oscillator

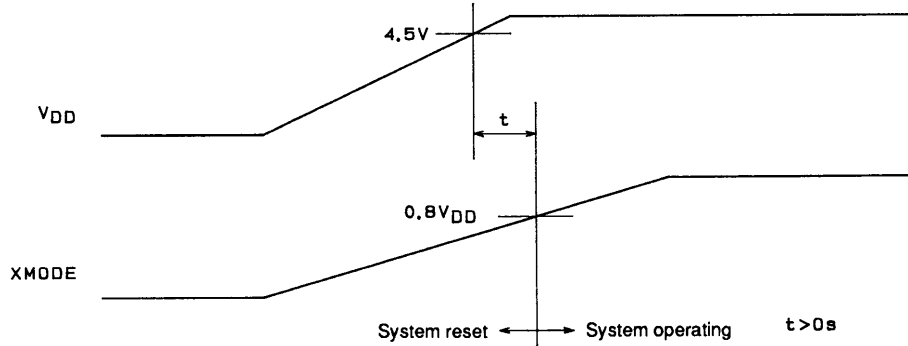
1. The presence or absence of data is determined by an internal detection circuit. This circuit operates on either the VCO or the crystal oscillator clock. When power is first applied, the clock is supplied from the VCO, and the LC8902/Q switches to the crystal oscillator if a no data state is detected. Here, if a clock signal was not supplied from the crystal oscillator after a no data state is detected, the whole system would stop and remain in the stopped state, since the detection circuit would not operate even if data were supplied.
2. The XIN and XOUT pins include a built-in oscillator amplifier circuit, and take on the following states when a crystal oscillator is connected.

| Pin | Data Present* | Data Absent |
|------|---------------|--|
| XIN | High | Accepts crystal oscillator input. |
| XOUT | Low | Outputs the inverted state of the XIN pin. |

Note: * The XIN pin is pulled-up internally when the LC8902/Q is in the data present state.

XMODE

The XMODE pin resets the LC8902/Q system. The LC8902/Q will start to function normally if a high level is applied to this pin after the power supply voltage rises above a value of at least 4.5 V.



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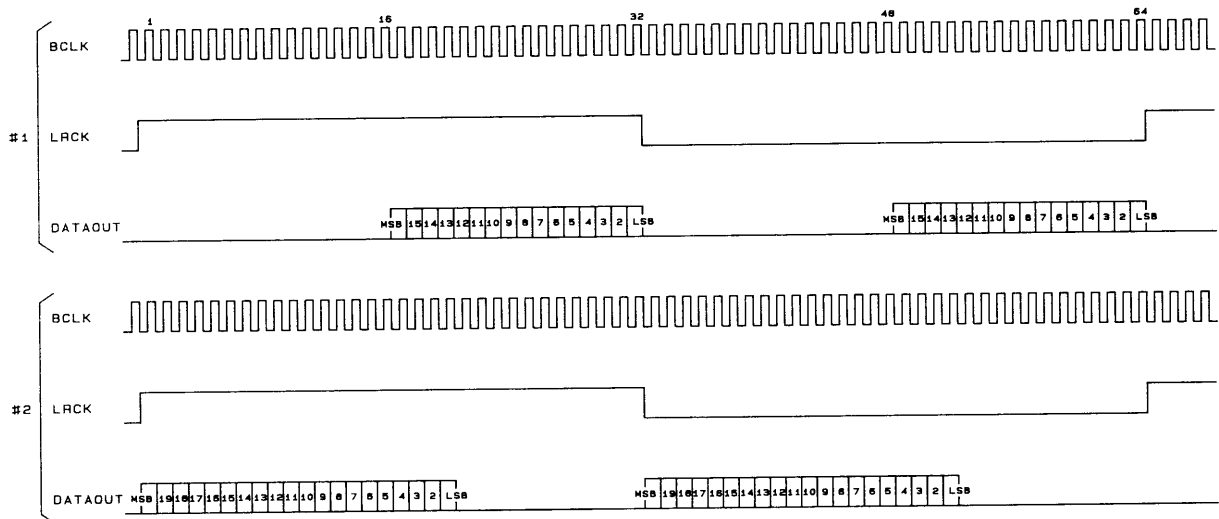
1. Once the LC8902/Q is operating, the system will be reset if a low level is applied once again to the XMODE pin.
2. This IC can be used without using the microcomputer interface by tying the CE, CL and DI microcomputer interface input pins low and using D1 as the data input pin. This technique can be used as a simplified method for product evaluation.

Data Output Timing

The figures show the data output timing.

1. Data is output in synchronization with the falling edge of the BCLK signal.
2. Data, BCLK and LRCK are output in synchronization with the rising edge of the 256 fs clock.
3. The data output timings for 20-bit MSB first and 16-bit MSB first output are shown in the timing charts.

Timing Chart

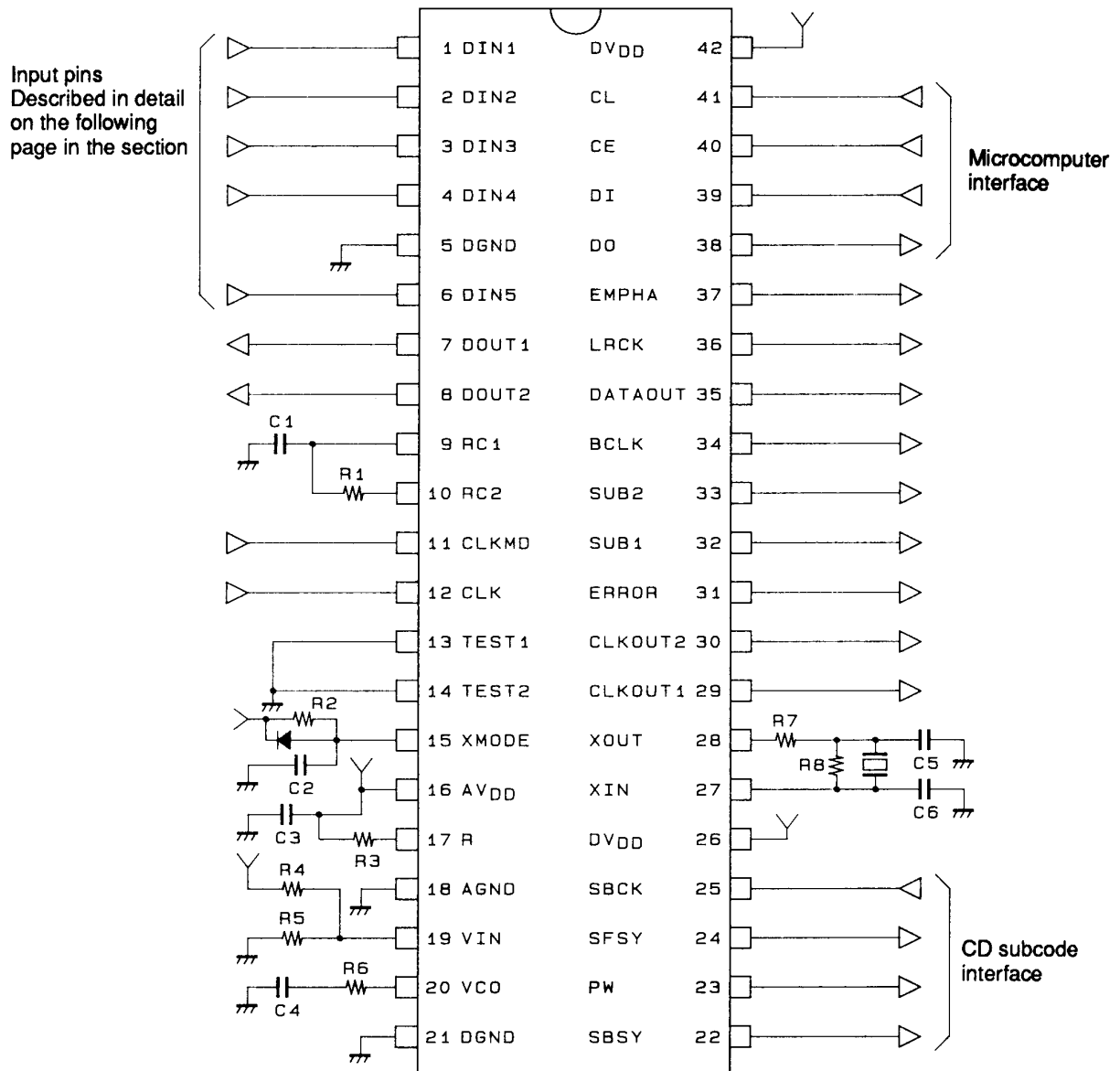


Timing chart #1 is for 16-bit MSB first output mode.
Timing chart #2 is for 20-bit MSB first output mode.

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Sample Application Circuit

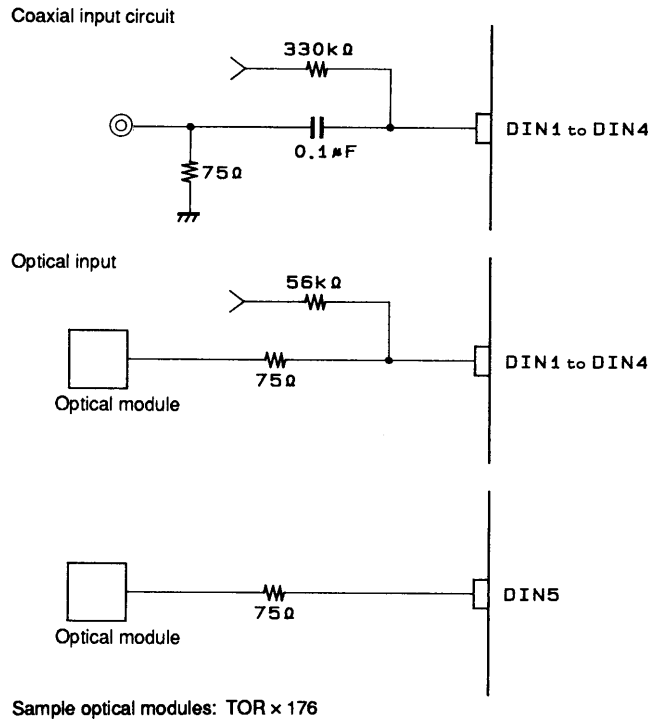


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Circuit Constants

| Item | Symbol | Value | Item | Symbol | Value |
|-----------|--------|--------------|------------|--------|--------------|
| Resistors | R1 | 33 kΩ | Capacitors | C1 | 1000 pF |
| | R2 | 10 kΩ | | C2 | 10 to 100 μF |
| | R3 | 24 kΩ | | C3 | 0.1 μF |
| | R4 | 5.6 kΩ | | C4 | 0.01 μF |
| | R5 | 5.6 kΩ | | C5 | 10 to 47 pF |
| | R6 | 120 to 150 Ω | | C6 | 10 to 47 pF |
| | R7 | 200 Ω | | | |
| | R8 | 200 kΩ | | | |

Input Pin Application Circuits



A00959

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