

Ordering number: EN3937

Monolithic Linear IC



No. 3937

LA3860

## Japanese Television Sound Demodulator with Built-in FM Stereo Decoder

### OVERVIEW

The LA3860 is a mono, stereo and bilingual television sound demodulator IC with built-in FM stereo decoder for use in Japanese home-stereo tuners. The TV and FM MPXs share a single ceramic resonator to reduce the external component count.

The LA3860 has automatic stereo (982.5 Hz) and bilingual (922.5 Hz) TV Q-signal detectors, and stereo TV/FM and bilingual TV indicator LED drivers. It has controls for selecting TV, FM and VCO-STOP (AM) modes and output muting, and for main-channel, sub-channel or dual output in bilingual TV mode. In VCO-STOP mode, both the TV and FM PLLs are halted. In bilingual TV mode, output selection is active while the bilingual Q-signal is detected.

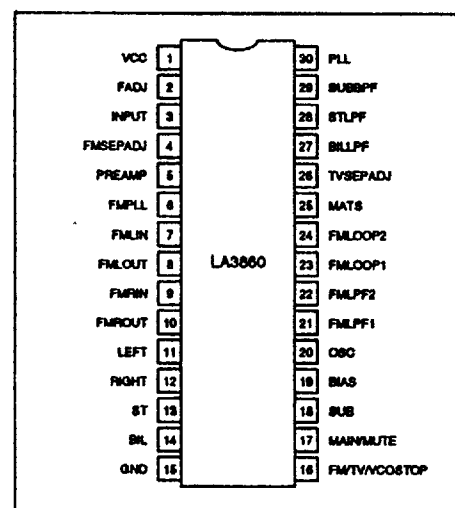
The LA3860 has adjustment-free digital (TV) and analog (FM) PLLs, internal 75  $\mu$ s TV (or AM in VCO-STOP mode) and external 50  $\mu$ s FM deemphasis, and separate TV and FM output amplifiers. It also has Q-signal and subchannel bandpass, and TV-FAX band-elimination filters. The subchannel demodulator functions by pulse-count detection.

The LA3860 operates from a 12 V supply and is available in 30-pin DIPs.

### FEATURES

- TV/FM PLLs and digital circuits use a single ceramic resonator to reduce component count.
- Adjustment-free TV and FM PLLs
- Complete demodulator requires only three adjustments.
- Independent TV and FM channel separation adjustments
- High Q-signal detector FM crosstalk rejection
- TV/FM, main-channel and subchannel switching can be controlled by microprocessor.
- Japanese TV-FAX (4.5f<sub>H</sub>) band-elimination filter
- Low switching noise when changing modes
- 12 V supply
- 30-pin DIP

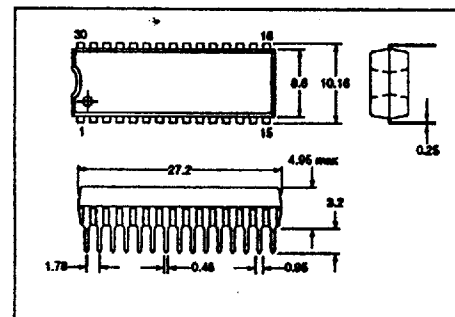
### PINOUT



### PACKAGE DIMENSIONS

Unit: mm

3061-DIP30SN

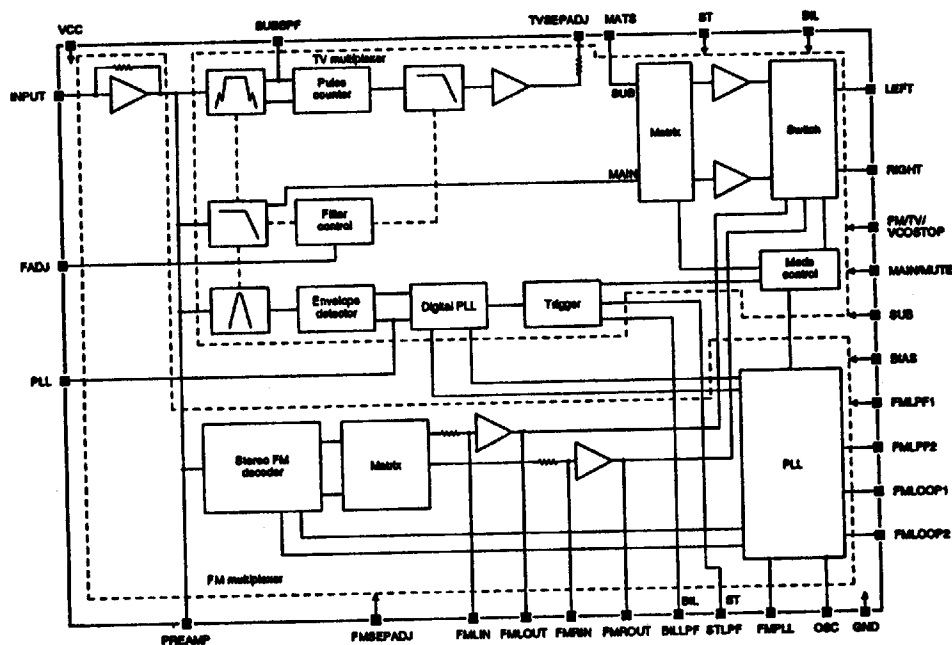


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BLOCK DIAGRAM



PIN DESCRIPTION

| Number | Name          | Description                                                                  |
|--------|---------------|------------------------------------------------------------------------------|
| 1      | VCC           | 12 V supply                                                                  |
| 2      | FADJ          | LPF and BPF bandwidth adjust. Nominal voltage is 1 V.                        |
| 3      | INPUT         | FM, TV and AM signal preamplifier inverting input. Nominal voltage is 5.2 V. |
| 4      | FMSEPADJ      | FM separation adjust. Nominal voltage is 5.2 V.                              |
| 5      | PREAMP        | Preamplifier output. Nominal voltage is 4.5 V.                               |
| 6      | FMPLL         | FM PLL input. Nominal voltage is 3 V.                                        |
| 7      | FMLIN         | FM left-channel output amplifier inverting input. Nominal voltage is 5.2 V.  |
| 8      | FMLOUT        | FM left-channel output amplifier output. Nominal voltage is 5.2 V.           |
| 9      | FMRIN         | FM right-channel output amplifier inverting input. Nominal voltage is 5.2 V. |
| 10     | FMROUT        | FM right-channel output amplifier output. Nominal voltage is 5.2 V.          |
| 11     | LEFT          | Left-channel AF output. Nominal voltage is 5.2 V.                            |
| 12     | RIGHT         | Right-channel AF output. Nominal voltage is 5.2 V.                           |
| 13     | ST            | Active-LOW stereo TV and FM indicator output. Open-collector output          |
| 14     | BL            | Active-LOW bilingual indicator output. Open-collector output                 |
| 15     | GND           | Ground                                                                       |
| 16     | FM/TV/VCOSTOP | FM, TV and VCOSTOP (AM) mode control input                                   |

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| Number | Name     | Description                                                                                               |
|--------|----------|-----------------------------------------------------------------------------------------------------------|
| 17     | MAINMUTE | Active-LOW bilingual main-channel select and output mute input                                            |
| 18     | SUB      | Active-LOW bilingual subchannel select input                                                              |
| 19     | BIAS     | TV main-channel deemphasis bias capacitor connection. Nominal voltage is 4.8 V.                           |
| 20     | OSC      | 455 kHz ceramic resonator (Murata CSE455F25) connection. Nominal voltage is 3.4 V.                        |
| 21     | FMLPF1   | FM pilot synchronous detector LPF connections. Nominal voltages are 3 V.                                  |
| 22     | FMLPF2   |                                                                                                           |
| 23     | FMLoop1  | FM pilot loop filter connections. Nominal voltages are 3 V.                                               |
| 24     | FMLoop2  |                                                                                                           |
| 25     | MATS     | TV matrix subchannel input. Nominal voltage is 4.5 V.                                                     |
| 26     | TVSEPADJ | TV separation adjust. Nominal voltage is 4.2 V.                                                           |
| 27     | BLLPF    | TV bilingual Q-signal (922.5 Hz) synchronous detector LPF capacitor connection. Nominal voltage is 3.9 V. |
| 28     | STLPF    | TV stereo Q-signal (982.5 Hz) synchronous detector LPF capacitor connection. Nominal voltage is 3.9 V.    |
| 29     | SUBBPF   | TV subchannel BPF capacitor connection. Nominal voltage is 3.1 V.                                         |
| 30     | PLL      | TV digital PLL capacitor connection. Nominal voltage is 4 V.                                              |

## SPECIFICATIONS

## Absolute Maximum Ratings

| Parameter                                   | Symbol           | Rating          | Unit |
|---------------------------------------------|------------------|-----------------|------|
| Supply voltage                              | V <sub>CC</sub>  | 14              | V    |
| ST and BL input voltage                     | V <sub>I1</sub>  | 14              | V    |
| RMTWVCOSTOP, MAINMUTE and SUB input voltage | V <sub>I2</sub>  | V <sub>CC</sub> | V    |
| ST and BL input current                     | I <sub>i</sub>   | 20              | mA   |
| Power dissipation                           | P <sub>D</sub>   | 1000            | mW   |
| Operating temperature range                 | T <sub>op</sub>  | -20 to 70       | °C   |
| Storage temperature range                   | T <sub>stg</sub> | -40 to 180      | °C   |

## Recommended Operating Conditions

T<sub>a</sub> = 25 °C

| Parameter                          | Symbol            | Rating   | Unit |
|------------------------------------|-------------------|----------|------|
| Supply voltage                     | V <sub>CC</sub>   | 12       | V    |
| Supply voltage range               | V <sub>CC</sub>   | 11 to 13 | V    |
| INPUT TV mono signal input voltage | V <sub>I TV</sub> | 80       | mV   |
| INPUT FM mono signal input voltage | V <sub>I FM</sub> | 240      | mV   |

## LA3860

## Electrical Characteristics

The input conditions for each operating mode are as follows.

- TV mono—80 mV, 1 kHz signal with 100% modulation
- TV stereo—1 kHz, L + R composite signal with 100% modulation and 55.069 kHz Q-signal with 982.5 Hz, 60% modulation
- Bilingual—1 kHz, main-channel composite signal with 100% modulation and 55.069 kHz Q-signal with 922.5 Hz, 60% modulation
- FM mono—240 mV, 1 kHz signal with 100% modulation
- FM stereo—1 kHz, L + R composite signal with 90% modulation and 19 kHz pilot with 10% modulation

## TV mode

$V_{CC} = 12\text{ V}$ ,  $T_a = 25\text{ }^{\circ}\text{C}$ , FM/TV/VCO STOP is 5 V.

| Parameter                                 | Symbol        | Condition                                            | Rating |       |      | Unit |
|-------------------------------------------|---------------|------------------------------------------------------|--------|-------|------|------|
|                                           |               |                                                      | min    | typ   | max  |      |
| Quiescent supply current                  | $I_{CCQ}$     |                                                      | 35     | 60    | 70   | mA   |
| FM to TV mode switch voltage              | $V_{FT}$      |                                                      | —      | 1.0   | —    | V    |
| TV to VCO STOP (AM) mode switch voltage   | $V_{VCO}$     |                                                      | —      | 7.8   | —    | V    |
| Bilingual main-channel switch OFF voltage | $V_{MMH}$     |                                                      | —      | 1.5   | —    | V    |
| Bilingual sub-channel switch OFF voltage  | $V_{MSH}$     |                                                      | —      | 1.5   | —    | V    |
| Mute ON input voltage                     | $V_{MUTE}$    |                                                      | —      | 7.2   | —    | V    |
| TV (AM) output voltage                    | $V_{O-TV}$    | Mono TV or 80 mV AM input                            | 800    | 708   | 1000 | mV   |
| LEFT and RIGHT output DC offset voltage   | $V_{TVOF}$    | Mono, stereo or bilingual input                      | —190   | 0     | 190  | mV   |
| TV/FM DC offset voltage                   | $V_{TVFM}$    | TV, FM or mute mode                                  | —320   | 0     | 320  | mV   |
| Mono signal-to-noise ratio                | $S/N_{TVMO}$  | See note.                                            | 60     | 72    | —    | dB   |
| Subchannel signal-to-noise ratio          | $S/N_{TVSH}$  | See note.                                            | 60     | 68    | —    | dB   |
| Mono total harmonic distortion            | $THD_{TVMO}$  | See note.                                            | —      | 0.1   | 1.1  | %    |
| Subchannel total harmonic distortion      | $THD_{TVSH}$  | See note.                                            | —      | 1.6   | 3.6  | %    |
| Main-channel to subchannel separation     | Sep           | See note.                                            | 30     | 42    | —    | dB   |
| Q-signal detection sensitivity            | QS            | Stereo or bilingual input                            | —      | 17    | 60   | mV   |
| Stereo Q-signal capture range             | $CR_{TVST}$   | $f_0 = 982.5\text{ Hz}$ ,<br>$f_0 = 974.4\text{ Hz}$ | —      | —0.84 | —    | %    |
|                                           |               | $f_0 = 982.5\text{ Hz}$ ,<br>$f_0 = 991.3\text{ Hz}$ | —      | 0.90  | —    |      |
| Bilingual Q-signal capture range          | $CR_{TVBL}$   | $f_0 = 922.5\text{ Hz}$ ,<br>$f_0 = 912.0\text{ Hz}$ | —      | —1.2  | —    | %    |
|                                           |               | $f_0 = 922.5\text{ Hz}$ ,<br>$f_0 = 942.2\text{ Hz}$ | —      | 2.1   | —    |      |
| Main-channel to subchannel crosstalk      | $C_{SH}$      | Bilingual input,<br>1 kHz BPF at input               | 60     | 67    | —    | dB   |
| Channel balance                           | CB            | TV or FM mode                                        | —1.5   | 0     | 1.5  | dB   |
| Mute attenuation                          | $Q_{MUTE-TV}$ |                                                      | 60     | 62    | —    | dB   |
| 7.5 kHz deemphasis attenuation            | $Q_{DE}$      | 1 kHz reference                                      | 9.1    | 11.1  | 13.1 | dB   |

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| Parameter                  | Symbol    | Condition                                           | Rating |     |     | Unit       |
|----------------------------|-----------|-----------------------------------------------------|--------|-----|-----|------------|
|                            |           |                                                     | min    | typ | max |            |
| Subchannel BPF attenuation | $A_{sub}$ | $f = 3f_H = 47.202 \text{ kHz}$ ,<br>100 mV input   | 3      | -   | -   | dB         |
|                            |           | $f = 4.5f_H = 70.803 \text{ kHz}$ ,<br>100 mV input | 11     | -   | -   |            |
| FADJ impedance range       | $R_{FA}$  |                                                     | 12     | -   | 22  | k $\Omega$ |

Note

IHF/T200 (200 Hz to 15 kHz) input bandpass filter

FM mode

$V_{CC} = 12 \text{ V}$ ,  $T_a = 25^\circ \text{C}$ , FM/TV/VCOSTOP is 0 V or open.

| Parameter                        | Symbol     | Condition                                             | Rating |           |      | Unit |
|----------------------------------|------------|-------------------------------------------------------|--------|-----------|------|------|
|                                  |            |                                                       | min    | typ       | max  |      |
| FM output voltage                | $V_{O FM}$ | FM mono input                                         | 708    | 1000      | 1418 | mV   |
| FMLPF2 forced mono input voltage | $V_F$      |                                                       | -      | 4.0       | 5.5  | V    |
| Mono signal-to-noise ratio       | $SN_{FM}$  | FM mono input                                         | 75     | 86        | -    | dB   |
| Mono total harmonic distortion   | $THD_{FM}$ | FM mono input                                         | -      | 0.01      | 0.20 | %    |
| Dynamic range                    | $D$        | 480 mV mono input                                     | -      | 0.04      | 0.30 | %    |
| Channel separation               | $Sep$      | Stereo input                                          | 40     | 57        | -    | dB   |
| Pilot detection sensitivity      | $PS$       | Stereo input                                          | 30     | 73        | 120  | mV   |
| Pilot hysteresis                 | $PH$       | Stereo input                                          | -      | 2.5       | 6.0  | dB   |
| Pilot capture range              | $CR_{FM}$  | Stereo input, $f_0 = 19 \text{ kHz}$ ,<br>24 mV input | -      | $\pm 1.3$ | -    | %    |
| Mute attenuation                 | $CMUTE FM$ |                                                       | 70     | 92        | -    | dB   |

Measurement Conditions

- The standard inputs are 80 mV,  $f = 1 \text{ kHz}$ , 100% modulation signal for TV mono and 240 mV,  $f = 1 \text{ kHz}$ , 100% modulation signal for FM mono.
- The TV-mode capture range is given by the following equations.

For stereo,

$$\left( \frac{f_{CR} - 982.5 \text{ Hz}}{982.5 \text{ Hz}} \right) \times 100\%$$

and for bilingual,

$$\left( \frac{f_{CR} - 922.5 \text{ Hz}}{922.5 \text{ Hz}} \right) \times 100\%$$

where  $f_{CR}$  is the upper and lower frequencies at which the stereo or bilingual LED turns ON. FM/TV/VCOSTOP is 5 V, and the input on PLL, 900 Hz to 1 kHz, 100 mV sine wave.

- The FM-mode capture range is given by the equation

$$\left( \frac{f_{CR} - 19 \text{ kHz}}{19 \text{ kHz}} \right) \times 100\%$$

where  $f_{CR}$  is the upper and lower frequencies at which the stereo LED turns ON. FM/TV/VCOSTOP is 0 V or open, and the input waveform, 24 mV at approximately 19 kHz.

- Crosstalk measurements are made with a 1 kHz input bandpass filter.
- The  $f = 3f_H$  and  $f = 4.5f_H$  subchannel bandpass filter attenuation is measured with respect to 47.202 kHz and 70.803 kHz, 100 mV input sine waves.
- The TV-mode DC offset voltage is given by the following equations.

$$V_{TVOF} = V_{ST} - V_{MONO}$$

$$V_{TVOF} = V_{MAIN} - V_{MONO}$$

$$V_{TVOF} = V_{SUB} - V_{MONO}$$

where  $V_{MONO}$ ,  $V_{ST}$ ,  $V_{MAIN}$  and  $V_{SUB}$  are the DC output voltages for mono, stereo and bilingual TV input signals (main-channel and subchannel), respectively. The TV/FM DC offset voltage is given by the following equations.

$$V_{TVFM} = V_{FM} - V_{TV}$$

$$V_{TVFM} = V_{MUTE} - V_{TV}$$

where  $V_{FM}$ ,  $V_{TV}$  and  $V_{MUTE}$  are the DC output voltages for FM mono, TV mono and muted output signals, respectively.

- The 456 kHz ceramic resonator connected to OSC is a Murata CSB456F28.

## LA3860

## OPERATING MODE SELECTION

| Mode                          |           | Control inputs    |           |      | Output signals |       | LED display |     |
|-------------------------------|-----------|-------------------|-----------|------|----------------|-------|-------------|-----|
|                               |           | FM/TW<br>VCO STOP | MAIN/MUTE | SUB  | LEFT           | RIGHT | ST          | BIL |
| FM (50 $\mu$ s<br>deemphasis) | Mono      | LOW               | x         | x    | Mono           |       | OFF         |     |
|                               | Stereo    |                   |           |      | Left           | Right | ON          | OFF |
| TV (75 $\mu$ s<br>deemphasis) | Mono      | HIGH              | x         | x    | Mono           |       | OFF         |     |
|                               | Stereo    |                   |           |      | Left           | Right | ON          | OFF |
|                               | Bilingual |                   | LOW       | LOW  | Main           | Sub   | OFF         | ON  |
|                               |           |                   | LOW       | HIGH | Main           |       |             |     |
|                               |           |                   | HIGH      | LOW  | Sub            |       |             |     |
| AM (75 $\mu$ s<br>deemphasis) | AM        | 10 V              | x         | x    | Mono           |       | OFF         |     |
| x                             |           | x                 | 10 V      | x    | Mute           |       | x           |     |

## Notes

1. LOW = 0 V or open, HIGH = 5 V, x = don't care
2. MAIN/MUTE and SUB should not both be HIGH simultaneously.

## Adjustments

## Filter adjustment

Input a stereo or bilingual TV signal and adjust the trimmer resistor connected to FADJ for maximum DC voltage on PLL.

## TV channel separation adjustment

After filter adjustment, input a composite TV signal (equivalent to an 80 mV mono signal) on one channel (left or right) and adjust the trimmer resistor connected to TVSEPADJ for minimum level on the other channel output.

## FM channel separation adjustment

Input a composite FM signal (equivalent to a 240 mV mono signal) on one channel (left or right) and adjust the trimmer resistor connected to FMSEPADJ for minimum level on the other channel output.

## DESIGN INFORMATION

## Input Signal Polarity

If the stereo left- and right-channel outputs are inverted or the bilingual main-channel and subchannel outputs

are reversed because of the sound IF amplifier signal polarity, invert the input signal using a transistor.

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