

The SL5162 multistandard modulator up-converts a baseband video signal with separate audio frequency input on to a VHF or UHF carrier up to 860MHz. It provides RF signals with negative or positive video modulation and AM or FM sound subcarrier to satisfy both PAL/NTSC and SECAM applications.

The on-chip local oscillator uses an external resonator tank which may be controlled via any Mitel 1.3GHz synthesiser. Selection of both video and sound standards are provided by level switching of a single pin.

A video AGC circuit is provided to ensure constant modulation depth. In PAL mode this may be disabled and a white clip circuit switched in to prevent overmodulation if desired.

### FEATURES

- Covers both Negative and Positive Modulation Systems
- Internal AGC with Disable
- Control of Sound and Video Standard via Single Pin
- Symmetrical 75Ω RF Outputs for Low Radiation
- Audio Input with AM/FM Sound Modulator
- Switchable Video Test Signal Generator (TSG)
- Intercarrier Input for Second Sound Channel
- ESD Protection

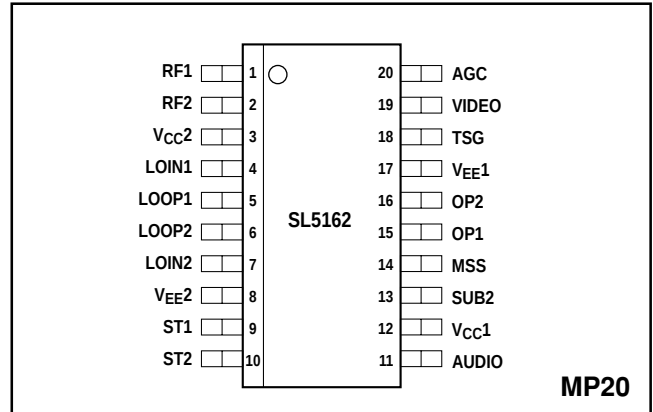


Figure 1 Pin connections – top view

### ORDERING INFORMATION

SL5162/KG/MP1S Miniature plastic package  
SL5162/KG/MP1T Tape and reel

### ABSOLUTE MAXIMUM RATINGS

|                          |                 |
|--------------------------|-----------------|
| Storage temperature      | –55°C to +150°C |
| Junction temperature     | –20°C to +150°C |
| Ambient temperature      | –10°C to +80°C  |
| Supply Voltage           | –0.3V to +7.0 V |
| Voltage at any other pin | –0.3V to +7.0V  |

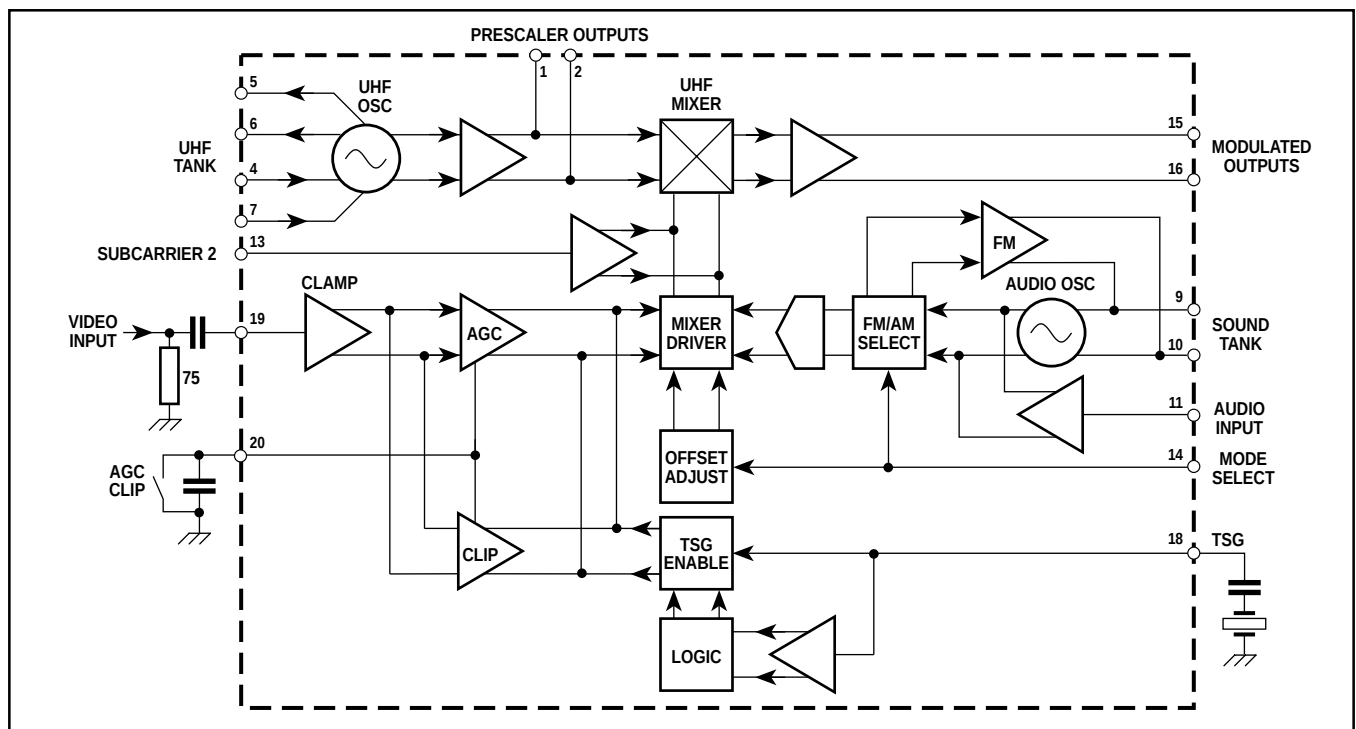


Figure 2 Block diagram

**ELECTRICAL CHARACTERISTICS**

$T_{AMB} = +25^{\circ}\text{C}$  (operating range  $-10^{\circ}\text{C}$  to  $+80^{\circ}\text{C}$ ),  $V_{CC} = +5\text{V}$ , (operating range  $+4.5$  to  $+5.5\text{V}$ ). Max and Min values are guaranteed by either production test or design. They apply within the specified temperature and supply voltage ranges unless otherwise stated.

| Characteristic                                         | Pin   | Value |         |         | Units      | Conditions                                                                                                                  |
|--------------------------------------------------------|-------|-------|---------|---------|------------|-----------------------------------------------------------------------------------------------------------------------------|
|                                                        |       | Min.  | Typ.    | Max.    |            |                                                                                                                             |
| Supply Voltage                                         | 3, 12 | 4.5   |         | 5.5     | V          |                                                                                                                             |
| Supply current                                         | 3, 12 |       | 45      | 53      | mA         |                                                                                                                             |
| <b>Video Input</b>                                     | 19    |       |         |         |            |                                                                                                                             |
| Video input level ( $V_P$ )                            |       | 0.5   | 1.0     | 1.5     | Vp-p       | $V_P = \text{sync to white level, AGC disabled (note 1)}$                                                                   |
| Eff. white clip level ( $V_C$ )                        |       |       | 1.17    |         | Vp-p       | $V_P = \text{sync to white level, AGC enabled}$                                                                             |
| Input impedance                                        |       |       | 100     |         | V          | $V_C = \text{sync to limit level (note 2)}$                                                                                 |
| Video bandwidth $-1\text{ dB}$                         |       | 10    |         |         | k $\Omega$ | Except for duration of clamp pulse                                                                                          |
| $-3\text{ dB}$                                         |       | 25    |         |         | MHz        |                                                                                                                             |
| Video SNR weighted                                     |       | 60    | 62      |         | MHz        |                                                                                                                             |
| Differential gain                                      |       |       | $\pm 2$ | $\pm 5$ | dB         | CCIR Rec 451-1 (note 3), mono sound system                                                                                  |
| Differential phase                                     |       |       | $\pm 2$ | $\pm 5$ | %          |                                                                                                                             |
| Line tilt (black level)                                |       |       |         | 0.5     | deg        | Dependent upon video input clamp capacitor                                                                                  |
| Clamp accuracy                                         |       |       |         | 5       | %          | $V_P = 1.0\text{V } \Delta$ (black level with and without input video)                                                      |
| <b>Audio Input</b>                                     | 11    |       |         |         | mV         |                                                                                                                             |
| Input impedance                                        |       | 15    | 25      |         | k $\Omega$ |                                                                                                                             |
| Audio bandwidth ( $-1\text{ dB}$ )                     |       | 4     |         | 7       | k Hz       |                                                                                                                             |
| Subcarrier frequency                                   |       |       | 0.5     | 1.0     | MHz        |                                                                                                                             |
| FM THD                                                 |       |       |         |         | %          | Determined by external components.<br>In demodulated signal. Input signal = 1 kHz sinewave at $\pm 35\text{ kHz}$ deviation |
| <b>Intercarrier Input</b>                              | 13    |       |         |         |            |                                                                                                                             |
| Input level                                            |       |       | 140     |         | mVp-p      | To define $-22\text{ dBc}$ (peak carrier)                                                                                   |
| <b>FM Performance</b>                                  | 11    |       |         |         |            |                                                                                                                             |
| Audio input for 100% deviation ( $\pm 35\text{ kHz}$ ) |       |       | 100     |         | mVp-p      | At device input                                                                                                             |
| FM deviation sensitivity                               |       |       | 0.7     |         | k Hz/mV    | Audio input 1 kHz sinewave                                                                                                  |
| Max frequency deviation                                |       | 250   |         |         | k Hz       | No pre-emphasis, dependent on external components                                                                           |
| <b>AM Performance Audio</b>                            | 11    |       |         |         |            |                                                                                                                             |
| Modulation depth                                       |       |       | 80      |         | %          | Input = 200mVp-p at 1 kHz                                                                                                   |
| Audio SNR (wideband)                                   |       | >46   |         |         | dB         |                                                                                                                             |
| <b>RF Output</b>                                       | 1, 2  |       |         |         |            |                                                                                                                             |
| Peak vision carrier:                                   |       |       |         |         |            |                                                                                                                             |
| SECAM (L)                                              |       |       | 83      |         | dB $\mu$ V | $V_P = 1.0\text{V}$ , sync = 0.3V                                                                                           |
| PAL                                                    |       |       | 84      |         | dB $\mu$ V | Differential 75 $\Omega$ output                                                                                             |
| Flatness band 470-860MHz                               |       |       |         | 2       | dB         |                                                                                                                             |
| APL $\Delta$                                           |       |       |         | $\pm 2$ | %          | APL 10-90%                                                                                                                  |
| <b>White Level, Nominal</b>                            | 1, 2  |       |         |         |            |                                                                                                                             |
| Negative modulation                                    |       | 12    | 17      | 22      | %          | Relative to peak vision carrier (PVC), $V_P = 1.0\text{V}$ , all systems (note 4)                                           |
| <b>Sync Tip</b>                                        | 1,2   |       |         |         |            |                                                                                                                             |
| Negative modulation                                    |       |       | 100     |         | %          | All systems                                                                                                                 |
| Positive modulation                                    |       |       | 6       |         | %          |                                                                                                                             |
| Sync degradation (+ve mod)                             |       |       | 1       |         | %          | $D_{\text{SYNC}} + (1 \pm \frac{S}{W} \times \frac{7}{3} \times 100)$                                                       |

**NOTES**

1. This is the nominal input level to provide the preset video modulation index for the selected standard. Any variation from the nominal level will change the RF modulation index.
2. The actual clip level is set relative to the input video level. The level of 1.17V only applies if the video input signal is correctly proportioned. The white clip circuit operates only when the AGC is disabled.
3. Measured at CH38 with R&S EMFP demodulator and UAF Video Analyser.
4. Measured at CH21 with R&S EMFP reference demodulator and UAF Video Analyser. Synchronous demodulation.

## ELECTRICAL CHARACTERISTICS (continued)

| Characteristic                                       | Pin     | Value |      |      | Units      | Conditions                                              |
|------------------------------------------------------|---------|-------|------|------|------------|---------------------------------------------------------|
|                                                      |         | Min.  | Typ. | Max. |            |                                                         |
| <b>Mod Index Control</b>                             |         |       |      |      |            |                                                         |
| Sound subcarrier level,<br>negative video modulation |         |       | – 16 |      | dBC        | Relative to PVC (note 4)                                |
| Sound subcarrier level,<br>positive video modulation |         |       | – 15 |      | dBC        | Relative to PVC, with no audio modulation applied       |
| Second sound subcarrier                              |         |       | – 22 |      | dBC        | Relative to PVC                                         |
| <b>Video Test Sig. Generator</b>                     | 18      |       |      |      |            |                                                         |
| Negative impedance                                   |         |       | – 3  |      | k $\Omega$ |                                                         |
| Ceramic resonator impedance                          |         |       | 500  |      |            |                                                         |
| <b>Prescaler</b>                                     | 1, 2    |       |      |      |            |                                                         |
| Output amplitude                                     |         |       | 30   |      | mVp-p      | Single ended from 50 $\Omega$                           |
| <b>Distortions</b>                                   |         |       |      |      |            |                                                         |
| Intermodulation:                                     |         |       |      |      |            | Values referred to PAL system G carrier level<br>Note 5 |
| $f_V + (f_S - f_C)$                                  |         |       | – 70 |      | dBC        |                                                         |
| $f_V + 2f_C$                                         |         |       | – 70 |      | dBC        |                                                         |
| $f_V + 2f_S$                                         |         |       | – 70 |      | dBC        |                                                         |
| $f_V + 3f_S$                                         |         |       | – 75 |      | dBC        |                                                         |
| Spurious (in band)                                   |         |       | – 70 |      | dBC        |                                                         |
| Spurious (ex band)                                   |         |       | – 70 |      | dBC        |                                                         |
| Harmonics:                                           |         |       |      |      |            |                                                         |
| $2f_V$                                               |         | – 10  |      |      | dBC        |                                                         |
| $3f_V$                                               |         | – 10  |      |      | dBC        |                                                         |
| Sound in vision                                      |         | – 60  |      |      | dBC        | Relative to 83dB $\mu$ V modulated carrier (note 6)     |
| Vision in sound                                      |         | – 46  |      |      | dBC        |                                                         |
| <b>Local Oscillator</b>                              | 4,5,6,7 |       |      |      |            |                                                         |
| Frequency range                                      |         | 38.9  |      | 860  | MHz        |                                                         |
| Residual FM                                          |         |       |      | 0.2  | kHz        | With 1Vp-p video input signal colour bars               |

## NOTES

5.  $f_V$  = vision carrier,  $f_S$  = sound subcarrier,  $f_C$  = chroma subcarrier.

6. SUB 2 must be connected to  $V_{CC}$  to achieve this performance.

| Pin | Name      | Function                              |
|-----|-----------|---------------------------------------|
| 1   | RF 1      | UHF prescaler output 1                |
| 2   | RF 2      | UHF prescaler output 2                |
| 3   | $V_{CC2}$ | Positive supply for UHF circuits      |
| 4   | LOIN 1    | UHF tank                              |
| 5   | LOOP 1    | UHF tank                              |
| 6   | LOOP 2    | UHF tank                              |
| 7   | LOIN 2    | UHF tank                              |
| 8   | $V_{EE2}$ | UHF ground                            |
| 9   | ST 1      | Sound tank 1                          |
| 10  | ST2       | Sound tank 2                          |
| 11  | AUDIO     | Audio 1 input                         |
| 12  | $V_{CC1}$ | Positive supply for baseband circuits |
| 13  | SUB 2     | Intercarrier (sound) input            |
| 14  | MSS       | Video modulation/standard select      |
| 15  | OP 1      | 75 $\Omega$ modulated output          |
| 16  | OP2       | 75 $\Omega$ modulated output          |
| 17  | $V_{EE1}$ | Baseband ground                       |
| 18  | TSG       | Test signal generator input           |
| 19  | VID       | Video input                           |
| 20  | AGC       | AGC capacitor/disable switch          |

Table 1 Pin descriptions

## VIDEO INPUT SECTION

A composite signal of the selected standard is applied to the device via a coupling capacitor also acting as the clamp storage capacitor. A minimum level clamp is used to DC restore the video signal in the IC to an internally defined reference voltage.

The AGC will give a constant output level with input signals between 0.5 and 1.5 Vp-p. If a controlled 1Vp-p video signal is available, the AGC may be disabled, in which case a white clip circuit is switched in, to prevent possible overmodulation.

Selection of negative or positive modulation is via a single pin (14). The voltage on this pin controls an offset which is fed to the UHF mixer, thus determining both modulation depth, and sense of modulation.

## SOUND SECTION

The sound is AC coupled and AM or FM modulated onto the pre-selected carrier, 4.5 - 6.5MHz; its level is nominally at – 16dB relative to the peak vision carrier.

## UHF MODULATED OUTPUT

Modulation and relative levels of vision and sound carrier levels are preset for the selected broadcast standard. Table 2 gives the output options available. Modulation index is fixed at 83% for all negative modulation systems and at 94% for SECAM standard L. Selection of sound tank frequency is defined by off-chip tank components.

| Standard  | Video      |                | Sound          |            |                         |
|-----------|------------|----------------|----------------|------------|-------------------------|
|           | Modulation | Mod. index (%) | SC freq. (MHz) | Modulation | Pre-emphasis ( $\mu$ s) |
| NTSC (M)  | Negative   | 83             | 4.5            | FM         | 75                      |
| PAL (G)   | Negative   | 83             | 5.5            | FM         | 50                      |
| PAL (I)   | Negative   | 83             | 6.0            | FM         | 50                      |
| SECAM (L) | Positive   | 94             | 6.5            | AM         | Through                 |

Table 2 Video modulation/standard selection

### TEST SIGNAL GENERATOR (TSG)

The internal test signal generator is driven from a 500kHz ceramic resonator. The TSG waveform is shown in Figure 3 and has an effective input video amplitude of 1V sync tip to white. Note that when TSG is enabled, the sound subcarrier modulation is disabled and so the audio is muted.

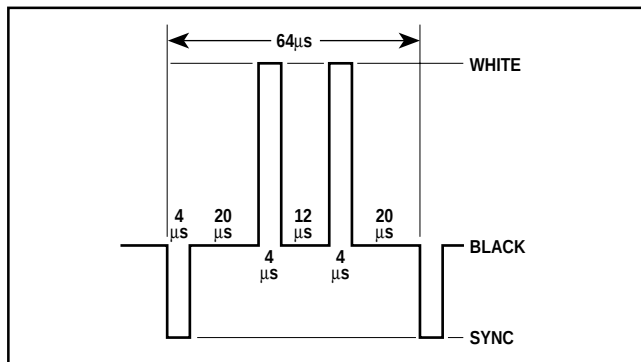


Figure 3 TSG waveform

### APPLICATION NOTES

The key to achieving acceptable modulator performance is to ensure a well planned circuit layout with good RF decoupling of all supplies and sensitive pins. Ground loops should be avoided or kept as small as possible since RF coupling is the single most important characteristic in degrading modulator performance. Where possible, double sided board with a ground plane should be used and care taken to decouple all sensitive pins as close to the device as possible.

### Oscillator Design and Layout

The oscillator layout should be kept as small as possible to minimise parasitics. It is also recommended that the ground plane is kept as far away from the oscillator itself since this will minimise the unwanted capacitance from the tank components to the ground plane. This has two advantages:

1. It increases the oscillator tuning range
2. It minimises the amount of RF coupled into the ground plane by the oscillator.

The circuit diagram shown in Figure 4 can be used for UHF or VHF applications. Surface mount components should be used wherever possible since these will minimise parasitics and also allow a more compact circuit design. For applications at VHF the values of the tuning components must be modified: the coupling capacitors should be increased to a value of 2.2pF or greater. For fixed frequency applications up to 100MHz (or limited tuning range applications) 15pF coupling capacitors can be used. Varactor tuning of the SL5162 should not be attempted unless the oscillator is synthesised, due to the wide temperature variation of varactor diodes. The application shown in Figure 4 uses a Mitel 1.3GHz TV synthesiser. This provides the required stability and tuning for the VCO. Any of the of the Mitel Media Products I<sup>2</sup>C and 3-wire bus synthesisers such as SP5611, SP5502, SP5026 should be suitable for use with the SL5162

### Modulated Outputs

The routing of the modulated outputs requires special attention since these are particularly vulnerable to coupling from the VCO: unwanted coupling of the LO frequency to the RF output will modify the modulation depth. Typically, in instances where RF coupling is present, the amount of coupling (and the phase) will vary as the oscillator is tuned across the band, causing the modulation index to be either higher or lower than the situation where no RF coupling is present. Thus the modulation index will vary as the device is tuned from one channel to another. For VHF and other applications below 500MHz, oscillator coupling is not such an issue, however similar care should still be taken with the layout in order to maximise device performance.

### Use of a Balun

It is possible to further improve device performance with the use of a balun to remove the effects of common mode coupling. Although using a balun will add to component cost, it may be the best way to achieve maximum performance at higher frequencies where common mode noise has made it impossible to achieve the required SNR or dynamic range in the output signal. A low cost balun wound on a ferrite bead former should be sufficient to provide adequate performance in the majority of applications.

### Sound Tank Circuit

It is recommended that the sound tank shown in Figure 4 is used. For PAL G, NTSC or SECAM applications, the value of the inductor may be modified to achieve the required subcarrier frequency. The tank circuit can be tuned between 4MHz and 7MHz. The sound subcarrier is automatically gain controlled to a value which gives a 16dB picture-to-sound carrier ratio when the SL5162 is set to negative modulation. The audio input signal is AC coupled through pin 11. The FM sensitivity of the of the sound section is 0.7kHz/mV, therefore a 140mVp-p input signal should give a  $\pm 50$ kHz deviation of the sound subcarrier.

### Stereo Sound

For stereo applications, a previously modulated second subcarrier should be input via the SUB 2 input (pin 13). For example, with the German Panda system, this would normally be at 5.74MHz. An input level of 200mV p-p should provide the required picture carrier/sound carrier ratio of 22dB.

### Video Modulation/Standard Selection

The SL5162 may be switched between negative and positive modulation standards via MSS, pin 14. This configures both the sense of video modulation (negative or positive), and switches the modulation on the sound subcarrier to AM when positive video modulation is selected. These standards are switched as shown in Table 3. To ensure reliable startup over the entire  $V_{CC}$  range it is recommended that the sound tank circuit is started via an effective pulse from the I<sup>2</sup>C bus synthesiser used in the system. This is shown in the demonstration board circuit, Figure 4. To do this, one of the

open collector outputs is initially turned on. This is then released when the mode selection (PAL/NTSC or SECAM) is made or at any other convenient point (e.g. when frequency data is sent) in PAL/NTSC mode. As an example, to synthesise 471·25MHz send the data words as shown in Table 4.

Care must be taken to ensure that the MSS pin is adequately decoupled as close to the pin as possible. The routing of any control line to this pin should also be laid out to ensure

| MSS pin voltage | Video modulation | Audio modulation |
|-----------------|------------------|------------------|
| 0V              | Negative         | FM               |
| 5V              | Positive         | AM               |

Table 3

| Data word | Description                                                                 |
|-----------|-----------------------------------------------------------------------------|
| C2        | Address synthesiser                                                         |
| 1D        | MSB frequency information                                                   |
| 74        | LSB frequency information                                                   |
| CE        | Charge pump high mode, standard operation                                   |
| B0        | Turn on port 5 to switch sound tank on                                      |
| CE        | Resend of byte 4                                                            |
| 10        | Turn on port 5, turn off port 4 (to configure SL5162 to PAL/NTSC operation) |
| STOP      | Stop bit (if required)                                                      |

Table 4

| Circuit ref. | Value         | Type                        |
|--------------|---------------|-----------------------------|
| R1           | 22k $\Omega$  | Surface mount 1206          |
| R2           | 22k $\Omega$  | Surface mount 1206          |
| R4           | 10k $\Omega$  | Surface mount 1206          |
| R5           | 22k $\Omega$  | Surface mount 1206          |
| R7           | 47k $\Omega$  | Surface mount 1206          |
| R8           | 1·6k $\Omega$ | Surface mount 1206          |
| R9           | 75 $\Omega$   | Surface mount 1206          |
| R10*         | 75 $\Omega$   | Surface mount 1206          |
| R11*         | 0 $\Omega$    | Surface mount 0805          |
| R12          | 0 $\Omega$    | Surface mount 1206          |
| R13          | 10k $\Omega$  | Surface mount 1206          |
| C1           | 18pF          | Surface mount 0805 100V COG |
| C2           | 100pF         | Surface mount 1206          |
| C3           | 100pF         | Surface mount 1206          |
| C4           | 220nF         | Surface mount 1206          |
| C5           | 47nF          | Surface mount 1206          |
| C6           | 10nF          | Surface mount 1206          |
| C7           | -             | BB515 varactor diode        |
| C8           | 5·6pF         | Surface mount 0805          |
| C9           | 100pF         | Surface mount 0805          |
| C10          | 10nF          | Surface mount 1206          |

\*Not fitted

maximum separation from the LO components whilst still remaining as short as possible. In PAL/NTSC (mono) applications, pin 13 (SUB 2) may be left open circuit or decoupled to ground via a 1nF capacitor. In SECAM (mono) applications pin 13 must be directly connected to  $V_{CC}$  to disable the intercarrier sound circuitry. For optimum performance it is recommended that in single ended output applications, pin15 is used for positive modulation, and pin 16 used for negative modulation.

### Test Signal Generator (TSG)

A TSG is provided which may be enabled by connecting a 500kHz ceramic resonator via a 56pF capacitor to the TSG pin (pin 18) as shown in Figure 4. The TSG is disabled by connecting pin 18 to ground. The waveform that the TSG produces (shown in Figure 3) will create two white bars on a standard TV screen. It should be noted that standard (video) modulation depth specification for the SL5162 in its normal application does not apply to the TSG facility, since it is only intended as a tuning or test mode.

### AGC/White Clip

The SL5162 is provided with an AGC circuit which should ensure correct modulation depth provided a composite video signal between 0·5V and 1·5V sync tip to peak white is applied to the VIDEO input, pin 19. If desired, the AGC may be disabled and a white clip circuit switched in to prevent overmodulation. This clipping level is set to a nominal 17% above peak white level, thus ensuring that even with a standard PAL I 95% saturated, 100% amplitude colour bars test signal, no clipping should take place. The AGC is enabled by connecting the pin 20 to Ground via a 150nF capacitor; white clip is enabled by connecting a 1·6k $\Omega$  resistor from pin 20 to ground.

| Circuit ref. | Value      | Type                            |
|--------------|------------|---------------------------------|
| C11          | 10nF       | Surface mount 1206              |
| C12          | 10nF       | Surface mount 1206              |
| C13          | 150pF      | Surface mount 1206              |
| C14          | 33nF       | Surface mount 1206              |
| C15          | 47 $\mu$ F | Electrolytic 0·1 inch pitch     |
| C16          | 150nF      | Surface mount 1206 (X7R)        |
| C17          | 680nF      | 0·2 inch pitch leaded capacitor |
| C18          | 56pF       | Surface mount 1206              |
| C19          | 10nF       | Surface mount 0805              |
| C20          | 10nF       | Surface mount 0805              |
| C21          | 100pF      | Surface mount 1206              |
| C22          | 1 $\mu$ F  | Electrolytic 0·1 inch pitch     |
| C23          | 10nF       | Surface mount 1206              |
| C24          | 220nF      | Surface mount 1206              |
| C25          | 100pF      | Surface mount 1206              |
| C26          | 100pF      | Surface mount 1206              |
| C27          | 1·5pF      | Surface mount 0603              |
| C28          | 1·5pF      | Surface mount 0603              |
| C29          | 1·5pF      | Surface mount 0603              |
| C30          | 1·5pF      | Surface mount 0603              |

contd...

Table 5 SL5162 demonstration board components parts list

| Circuit ref. | Value | Type                       |
|--------------|-------|----------------------------|
| SK1-4        | -     | BNC straight square socket |
| P1-2         | -     | 3-way PCB header           |
| P5           | -     | 2-way PCB header           |
| LK1          | -     | Link                       |
| SW1          | -     | 2×SPST DIL switch          |
| IC1          | -     | Mitel SP5611               |
| IC2          | -     | Mitel SL5162               |

| Circuit ref. | Value  | Type                         |
|--------------|--------|------------------------------|
| TR1          | -      | NPN transistor, BCW31, SOT23 |
| L1           | 5-6μH  | TOKO choke                   |
| L2           | -      | 1 turn 5mm diameter 22 SWG   |
| L3           | -      | 2 turns 5mm diameter 22 SWG  |
| X1           | 4MHz   | IQD crystal                  |
| X2           | 500kHz | Ceramic resonator            |

Table 5 SL5162 demonstration board components parts list (continued)

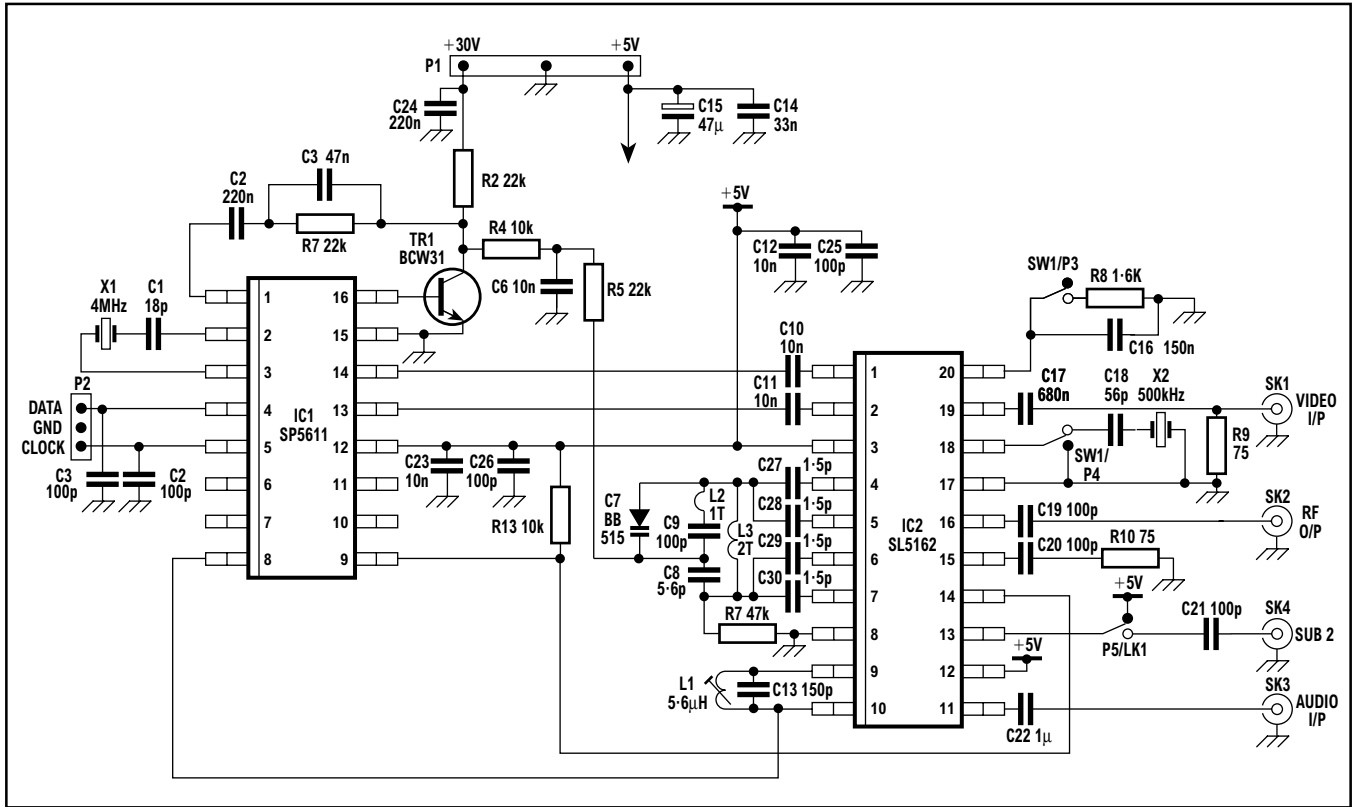


Figure 4 SL5162 demonstration board

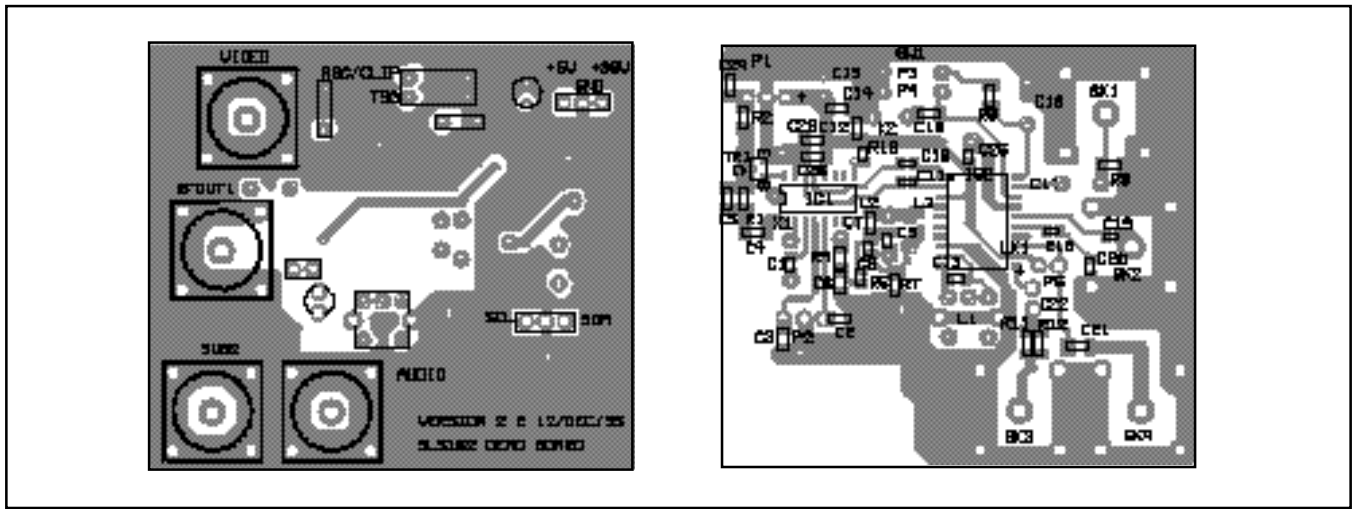


Figure 5 Demonstration board layout

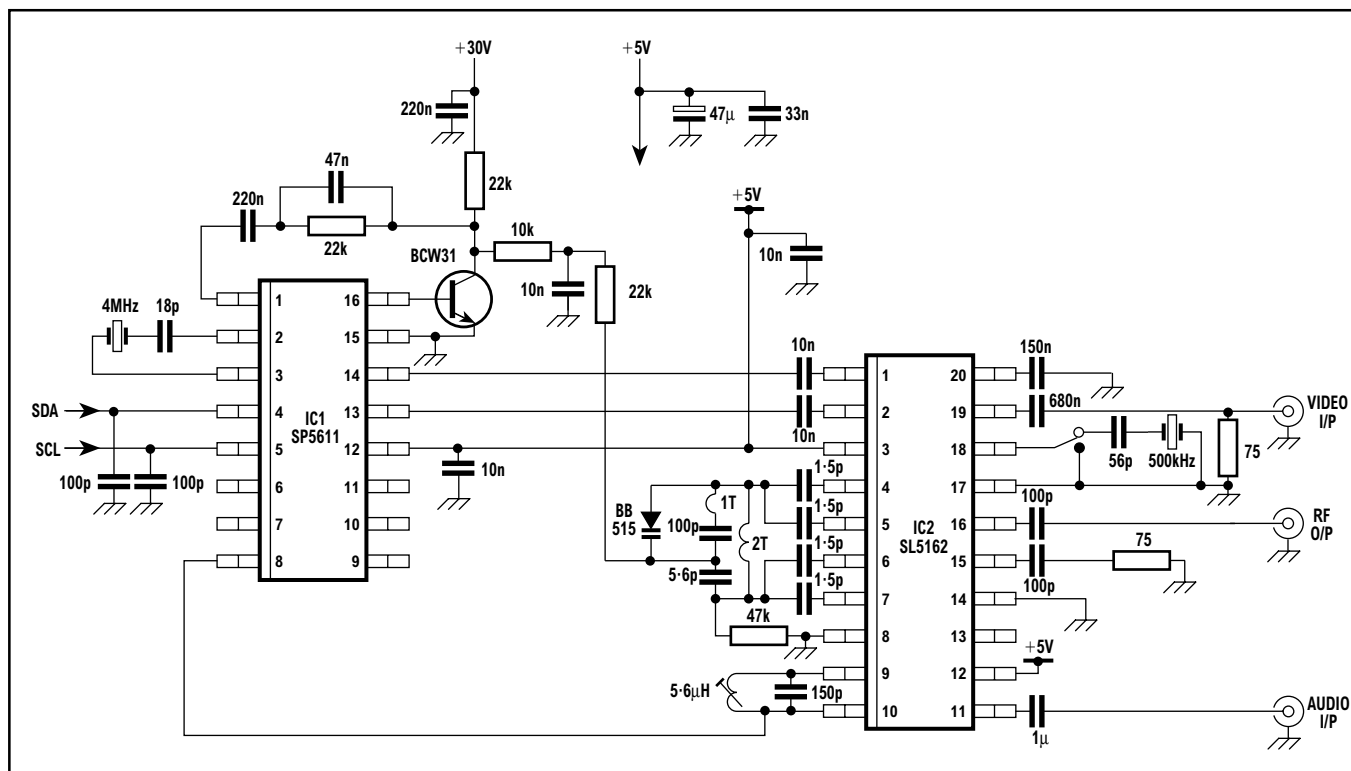


Figure 6 PAL (mono) application

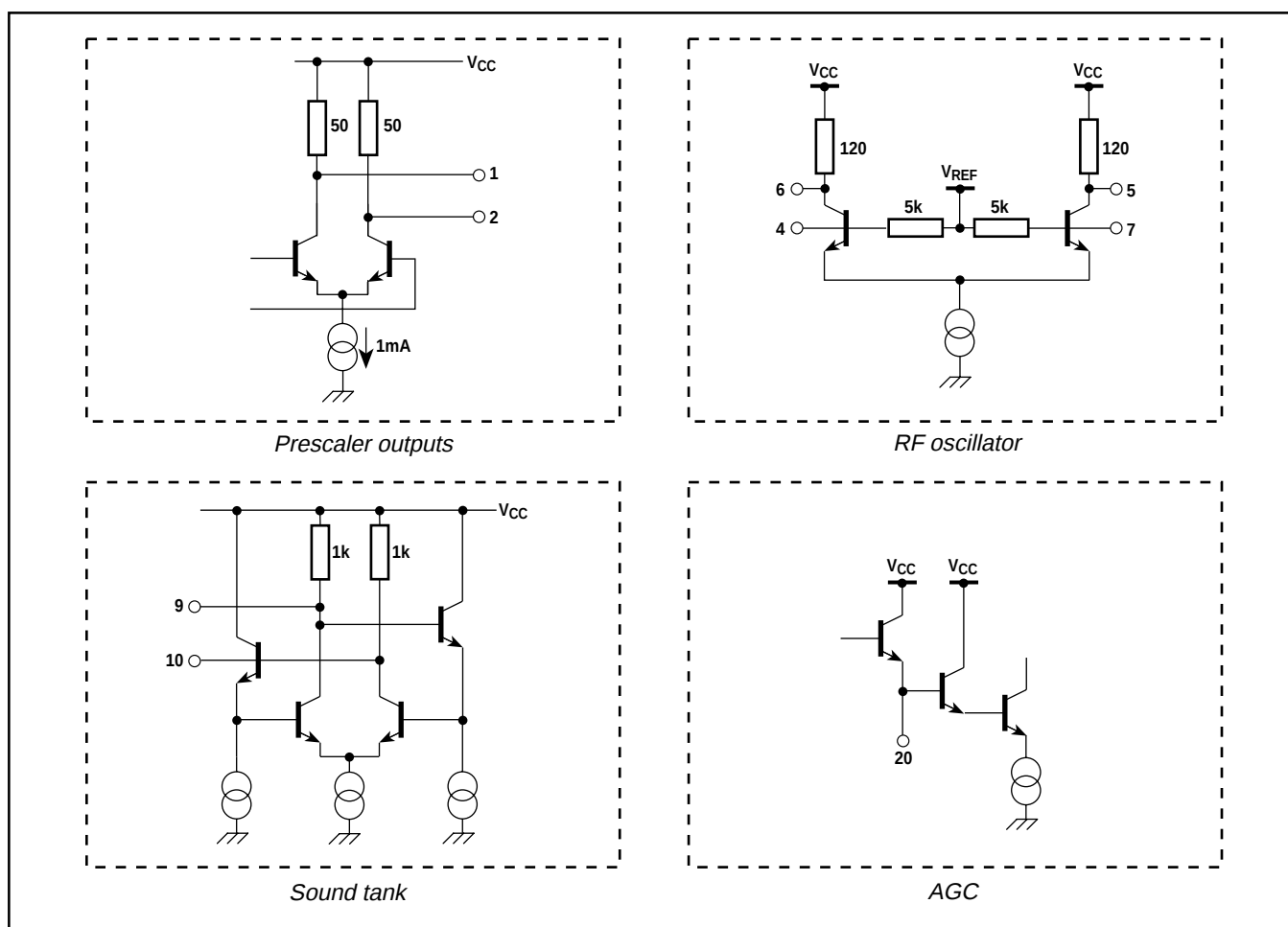


Figure 7 I/O interface circuits

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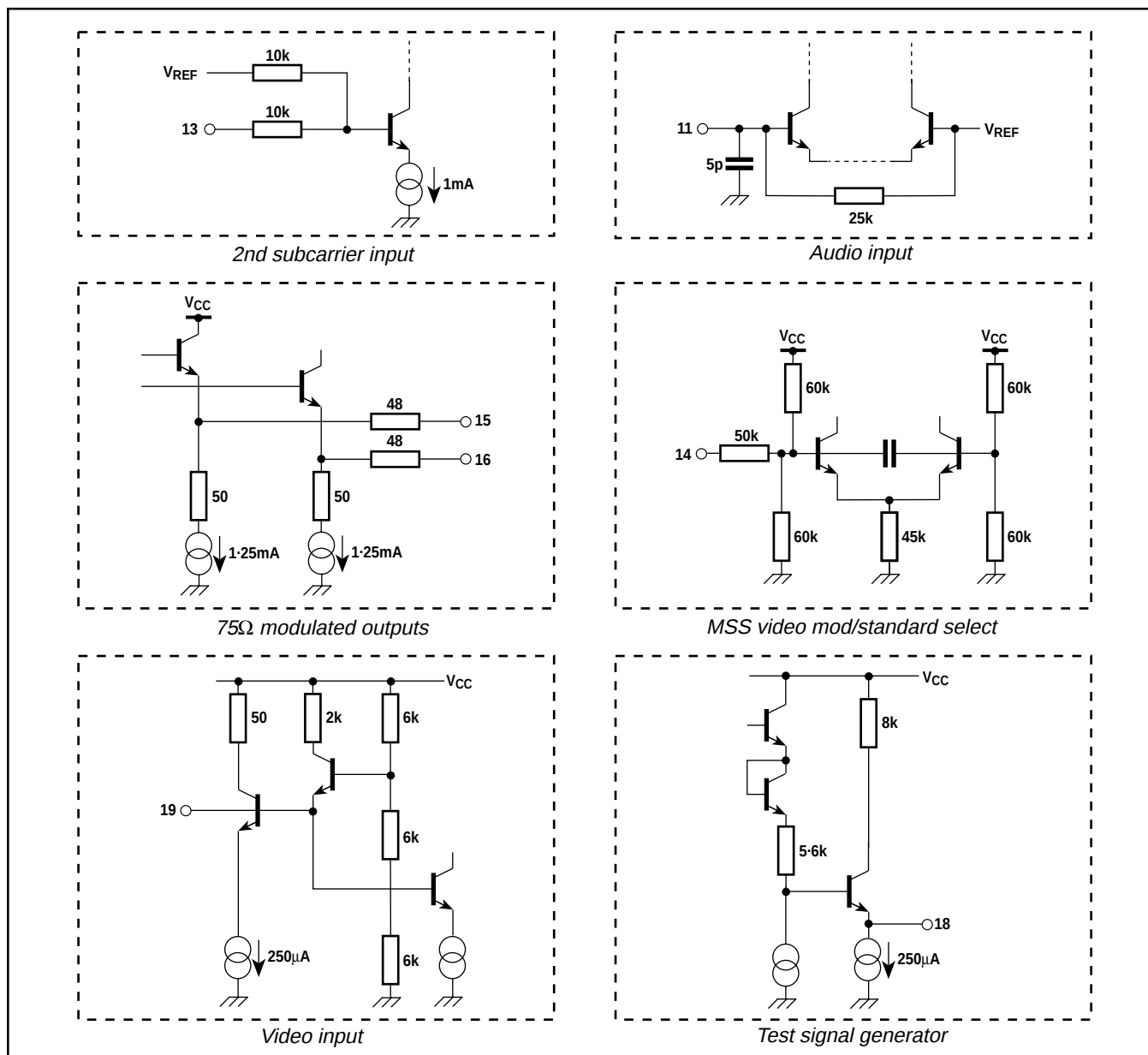


Figure 7 I/O interface circuits (continued)

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