PLESSEY
SEMICONDUCTORS
1641 Kaiser Avenue
Irvine, CA. 92714

SL6000 SERIES
COMMUNICATIONS CIRCUITS

SL6600C
LOW POWER IF/AF PLL CIRCUIT FOR NARROW BAND FM

The SL6600 is a single or double conversion IF amplifier and detector for FM radio applications. Its minimal power consumption makes it ideal for hand held and remote applications where battery conservation is important. Unlike many FM integrated circuits the SL6600 uses an advanced phase locked loop detector capable of giving superior signal-to-noise ratio with excellent co-channel interference rejection, and operates with a second IF frequency of less than 1MHz. Normally the SL6600 will be fed with a first IF signal of 10.7 or 21.4MHz; there is a crystal oscillator and mixer for conversion to the second IF amplifier, a PLL detector and squelch system.

FEATURES

- High Sensitivity: 5μV minimum
- Low Power: 1.5mA typical at 7V
- Advanced PLL Detector
- Available in Miniature 'Chip Carrier' Package
- 50dB S/N Ratio

APPLICATIONS

- Low Power NBFM Receivers

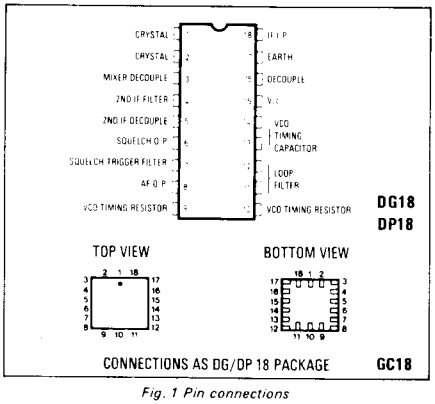


Fig. 1 Pin connections

QUICK REFERENCE DATA

- Supply Voltage 7V ± 0.5V
- Input Dynamic Range 100dB min.

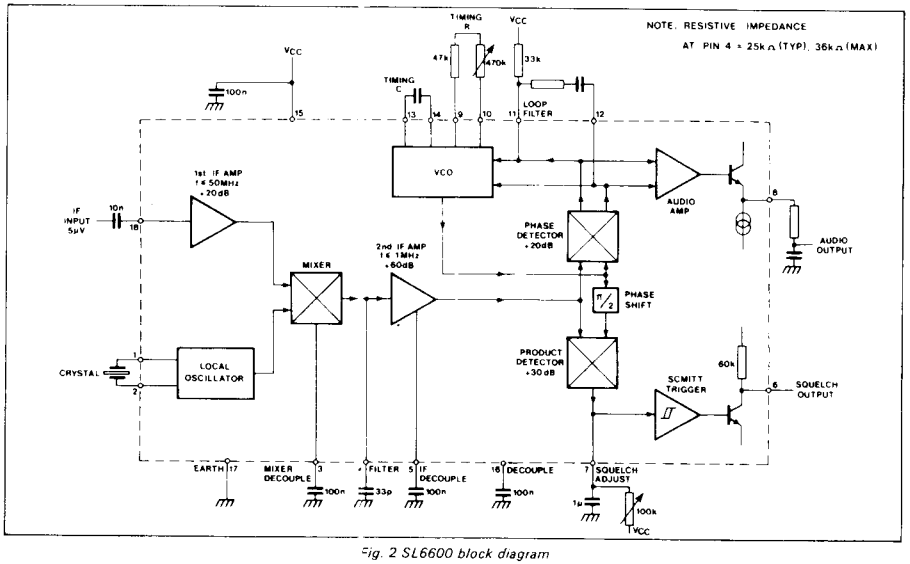


Fig. 2 SL6600 block diagram

ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated):
Supply voltage V_{CC} : 7V ±0.5V
Input signal frequency: 10.7MHz, frequency modulated with a 1 kHz tone with ±1.5kHz frequency deviation.
Ambient temperature: −30°C to +85°C

Characteristic	Value			Units	Conditions
	Min.	Typ.	Max.		
Supply current		1.5	2.5	mA	
First IF input impedance		910		Ω	
Input dynamic range	100	120		dB	1dB change in AF output
Maximum input level	2			V rms	
Input sensitivity	5	3		µV rms	50 Ω source, S + N/N = 20dB
Audio output	20	50	80	mV rms	1mV rms input level
Audio THD		1.3	3	%	1mV rms input level
S + N/N	30	50		dB	1mV rms input level
AM rejection	30	40		dB	30% AM, 100µV rms Input
Squelch low level	0	0.2	0.5	V	20µV rms input
Squelch high level	V_{CC} −0.5	V_{CC} −0.1	V_{CC}	V	No input
Squelch hysteresis		2		dB	

APPLICATION NOTES

IF Amplifiers and Mixer

The SL6600 can be operated either as a single conversion circuit with a maximum recommended input frequency of 800kHz or in a double conversion mode with a first IF of the input frequency (50 MHz max.) and a second IF of 100kHz or ten times the peak deviation, whichever is the larger. The crystal oscillator frequency can be equal to either the sum or difference of the two IF's; the exact frequency is not critical.

The circuit is designed to use series resonant fundamental crystals between 1 and 25MHz.

When a suitable crystal frequency is not available a fundamental crystal of one third of that frequency may be used.

When a single conversion circuit is required a 6.8k resistor should be connected in place of the crystal and a further 2.7k resistor connected between pin 1 and earth. The overall gain of the circuit will be reduced by 12dB with this technique.

A capacitor connected between pin 4 and ground will shunt the mixer output and limit the frequency response of the input signal to the second IF amplifier. A value of 33pF is advised when the second IF frequency is 100kHz.

Phase Locked Loop.

The Phase Locked Loop detector features a voltage controlled oscillator with nominal frequency set by an external capacitor according to the formula $\left(\frac{39}{f}\right)$pF, where f is the VCO frequency in MHz. The nominal frequency may differ from the theoretical but there is provision for a fine ±10% frequency adjustment by means of a variable resistor between the VCO output pins; a value of 470k has negligible effect while 47k (recommended minimum value) increases the frequency by approx. 10%.

The loop filter is connected between pins 11 and 12; a 33k resistor is also required between pin 11 and Vcc.

The values of the filter resistor R_2 and capacitor C_1 must be calculated so that the natural loop frequency fn and damping factor ξ are suitable for the FM deviation and modulation bandwidth required. Values of 6.2kΩ and 2.2nF are recommended for 5kHz maximum deviation and 3kHz audio bandwidth when the second IF frequency is 100kHz. These give fn 20kHz, ξ = 0.707.

Squelch Facility

When inputs to the product detector differ in phase a series of current pulses will flow out of pin 7. This feature can be used to adjust the VCO; when a 1mV unmodulated input signal is applied to pin 18 the VCO frequency should be trimmed to maximise the voltage on pin 7.

The squelch level is adjusted by means of a preset variable resistor between pin 7 and Vcc to set the output signal to noise ratio at which it is required to mute the output. The capacitor between pin 7 and ground determines the squelch attack time. A value between 10nF and 10µF can be chosen to give the required characteristics.

Outputs

High speed data outputs can be taken direct from pins 11 and 12 but normally for audio applications pin 8 is used. A filter network will be needed to restrict the audio bandwidth and an RC network consisting of 4.7 kΩ and 4.7nF may be used.

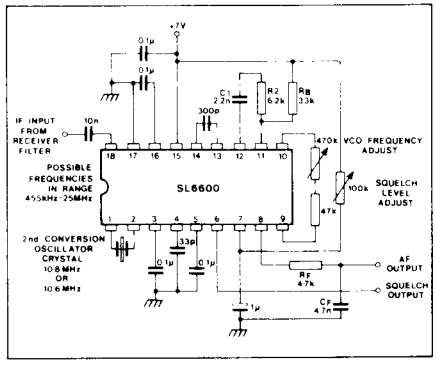
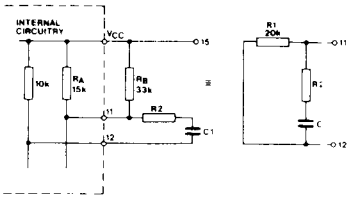


Fig.3 SL6600 application diagram (1st IF = 10.7MHz, 2nd IF = 100kHz



K_o ... 2.4f_o radians/volt-second
K_D ... 2.8 volts/radian
f_o ... 2nd IF frequency
f_n ... natural loop frequency

From theory:

$$2\pi f_n \quad \left(\frac{K_o K_D}{\tau_1 + \tau_2}\right)^{\frac{1}{2}}$$

Damping factor ξ $\quad \frac{1}{2}\left(\frac{K_o K_D}{\tau_1 + \tau_2}\right)^{\frac{1}{2}}\left(\tau_2 + \frac{1}{K_o K_D}\right)$

Fig. 4 Loop filter

TYPICAL CHARACTERISTICS

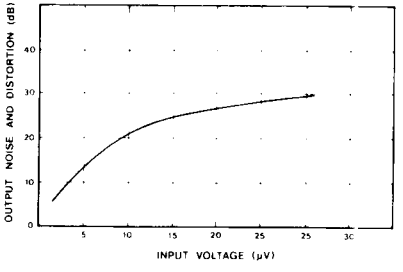


Fig. 5 Typical SINAD (Signal In/Noise & Distortion) Characteristics

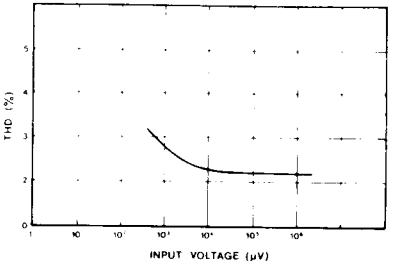


Fig. 6 Typical audio total harmonic distortion v. input signal voltage

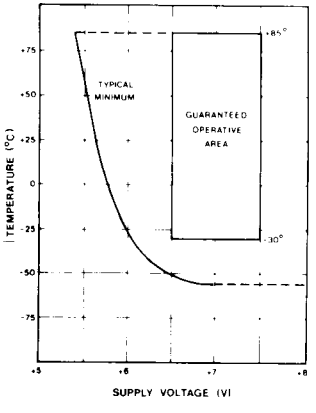


Fig. 7 Supply voltage v. temperature

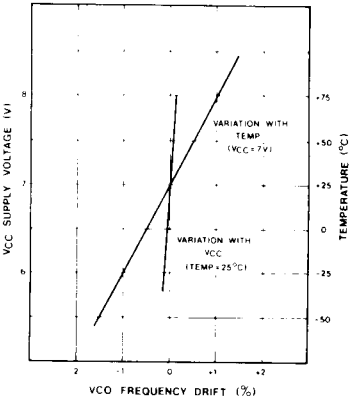


Fig. 8 Stability of VCO