Ordering number: EN 2208A

Monolithic Linear IC

No.2208A

SANYO

LA7770

FSK Receiver for CATV Use

Overview

The LA7770 is a CATV-oriented wide-band FSK (frequency shift keying) receiver IC encapsulated in a DIP20S package that incorporates the functions required to demodulate scramble decoding data (i. e., the oscillator, mixer, limiting IF amplifier, squelcher, and data shaper functions).

Features

- High limiting sensitivity.
- Incorporating a common-collector oscillator enables LC, crystal, or SAW-R (surface acoustic wave resonator) operated oscillations, as required by application.

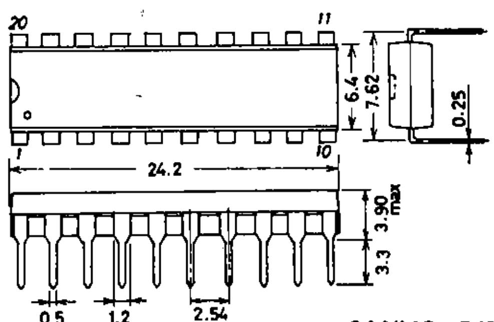
Functions

- Mixer
- Limiting IF amplifier
- Squelch meter drive
- Oscillator
- Quadrature detector
- Data shaper

Package Dimensions

unit : mm

3021B-DIP20



Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC}4$ max		15	V
	$V_{CC}6$ max		15	V
Maximum flow-in current	I_{18} max		3	mA
Allowable power dissipation	Pd max	Ta≦65°C	770	mW
Operating temperature	Topr		−20 to +85	°C
Storage temperature	Tstg		−55 to +125	°C

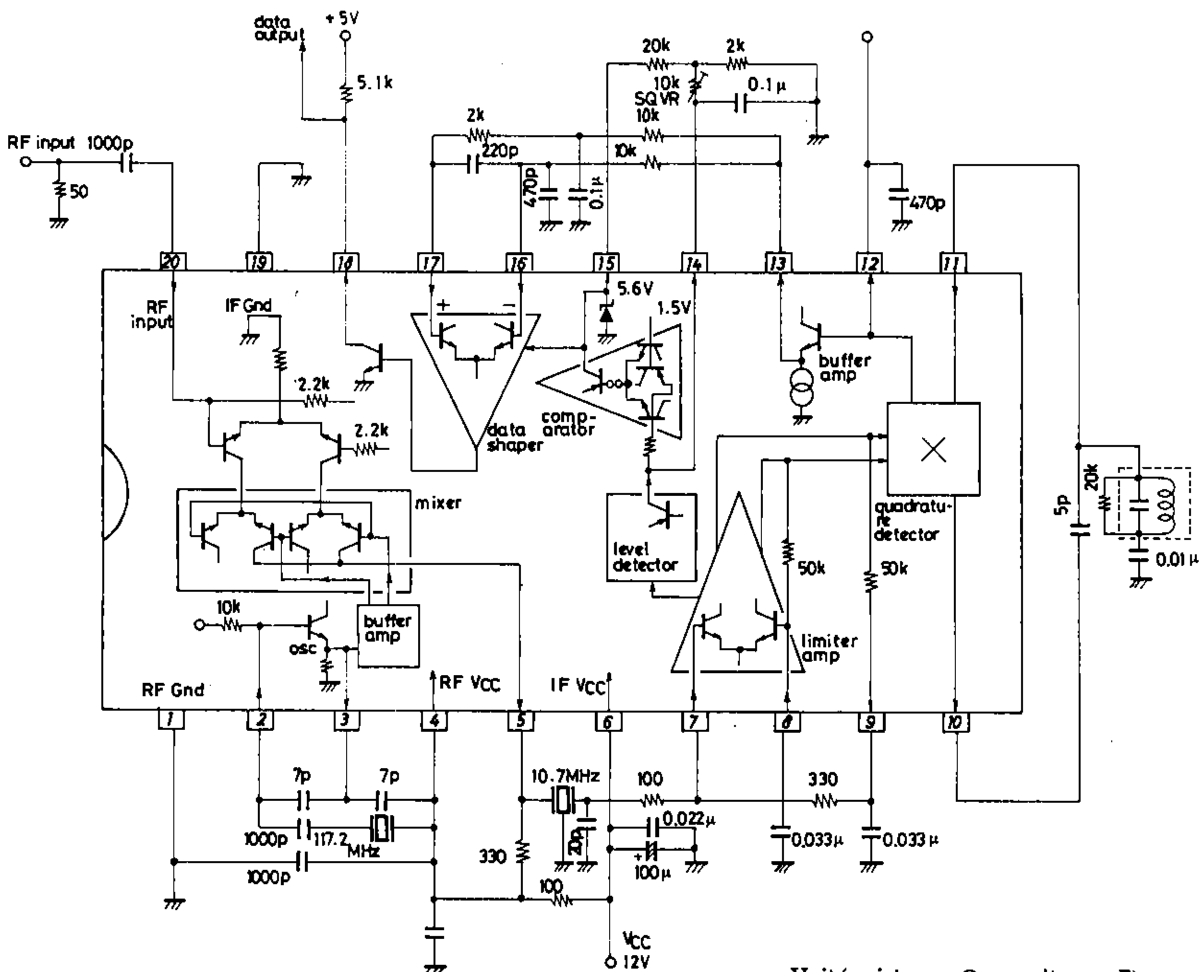
Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Operating voltage range	$V_{CC}4$		9 to 12	V
Operating voltage range	$V_{CC}6$		9 to 12	V
Comparator input voltage range	V16, V19		2V to (V_{CC}−2V)	V

Operating Characteristics at Ta = 25°C

Parameter	Symbol	Conditions	min	typ	max	Unit
Quiescent current	Icco	SQ-off	22	29	37	mA
Circuit current	I_{CC}	SQ-on	23.0	30.5	39.0	mA
Mixer input capacitance	ci	100MHz		7		pF
Mixer input resistance	ri	100MHz		680		Ω
Mixer voltage gain	Vgm	R_L = 330Ω,106.5M→10.7M	9	12	15	dB
−3dB limiting sensitivity	Vi	Δ_F = ±75kHz dev,at 1kHz		25	31	dB/μV
S/N	S/N	Δ_F = ±75kHz dev,at 1kHz	47	55		dB
Total harmonic distortion	THD	Δ_F = ±75kHz dev,at 1kHz		0.6	2	%
Demodulation output	Vo	Δ_F = ±75kHz dev,at 1kHz	300	440	600	mVrms
AM rejection	AMR	AM : 30% at 1kHz	47	55		dB
Meter drive	I_D	300μA→600μA	5	12	20	μA/dB
Squelch threshold voltage	V_{14TH}	DC	0.8	1.5	2.2	V
Data shaper input current	I_{16}	DC		0.7	3.0	μA
Output saturation voltage	$V_{18(sat)}$	I_{18} = 2mA		0.1	0.7	V
Duty	| TD |	f = 14kHz		2.5	5.0	%

Equivalent Circuit Block Diagram



Unit (resistance : Ω, capacitance : F)

LA7770 Dynamic Behavior and Cautions on Designing

(1) Mixer

A double differential type mixer is employd with its input circuit configured as shown in Fig.1, where the input signal is mixed with the oscillator output by its double differential circuit.
The mixed signal will be output from its open collector pin 5.

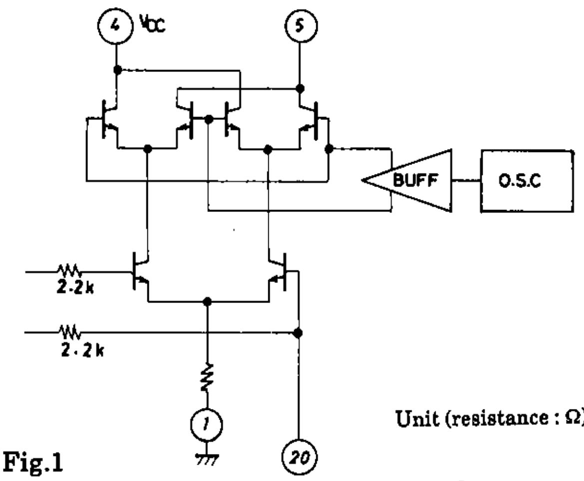


Fig.1

Unit (resistance : Ω)

Caution

a. Since an internal bias is applied to the input pin (pin 20), be sure to provide a DC blocking capacitor as shown in Fig.2.
b. Connect the decoupling capacitor across pins 4 and 1 with the shortest possible wiring.

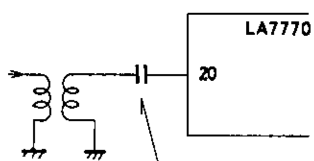


Fig.2

(2) Oscillator

A common-collector oscillator is employed as shown in Fig.3, and enables the LC, crystal, or SAW-R operated oscillations.

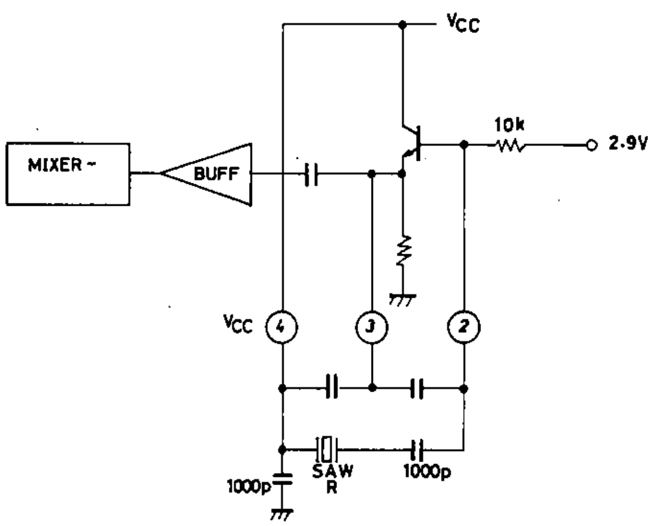


Fig.3

Unit (resistance : Ω, capacitance : F)

(3) IF Limiting Amplifier

The limiter amp employed is made up of DC feedback-provided 6-stage direct-coupled differential amplifiers. Simplified, its circuit is represented in Fig.4 below.

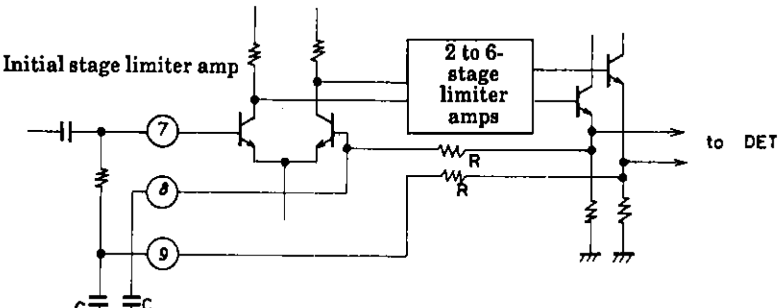
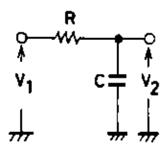


Fig.4



Feedback gain (A_V) will be $A_V = \frac{A}{1+A\beta} = \frac{1}{\frac{1}{A}+\beta} \fallingdotseq \frac{1}{\beta}$

where feedback depth $\beta = \left|\frac{V2}{V1}\right| = \frac{1}{\sqrt{1+(\omega CR)^2}}$

so that the decoupling capacitor C should be made sufficiently large in capacitance within the operating frquency band to achieve its low impedance.

(4) Quadrature Detector

The quadrature detector converts a frequency-modulated signal into a phase-modulated one by passing it through a phase shifter, and then demodulates it by converting it again into voltage with its phase detector.

The quadrature detector block of the LA7770 is configured as shown in Fig.5 below.

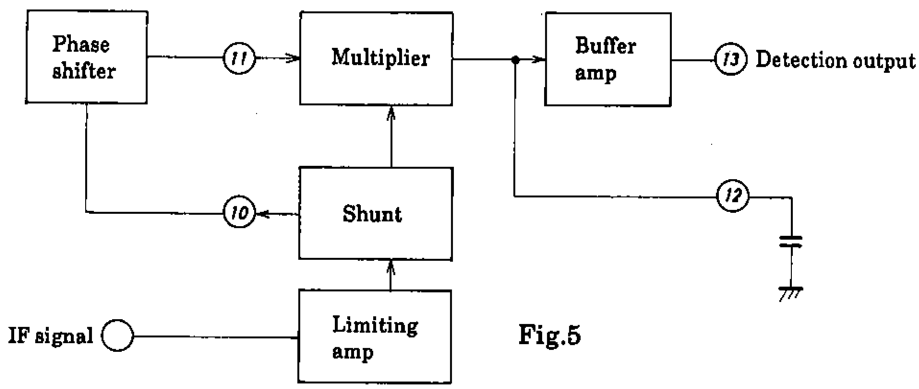


Fig.5

Phase Shifter

The phase shifter is an important element of the quadrature detector, and it dictates the detection characteristics of the latter.

The following phase-shifter-related parameters may be cited.

1. Demodulation output .... Chiefly QL
2. Distortion Factor .... Phase shifter linearity and symmetry of S curve

*While the phase shifting linearity may be enhanced with a single tuning circuit by lowering its QL and broadening its frequency band, its demodulation output will also be lowered in the process.

Single Tuning Circuit Phase Shifter

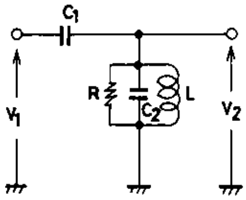


Fig.6

In the Fig.6 phase shifter,

$$\frac{V2}{V1}=\frac{\dfrac{1}{j\omega C2+\dfrac{1}{R}+j\omega L}}{\dfrac{1}{j\omega C1}+\dfrac{1}{j\omega C2+\dfrac{1}{R}+j\omega L}}=\frac{1}{\dfrac{\omega^2L(C1+C2)-1}{\omega^2LC1}-j\dfrac{1}{\omega C1R}}$$

Requirements to achieve a 90° phase shift will be :

$$\omega^2L(C1+C2)=1 \qquad \therefore f=\frac{1}{2\pi\sqrt{L(C1+C2)}}$$

$$\omega=\frac{1}{\sqrt{L(C1+C2)}}$$

$$\left|\frac{V2}{V1}\right|=\frac{1}{\sqrt{\left(\dfrac{\omega^2L(C1+C2)-1}{\omega^2LC1}\right)^2+\left(\dfrac{1}{\omega^2C1R}\right)^2}}$$

At the tuning point :

$$\left|\frac{V2}{V1}\right|=\frac{1}{\sqrt{\left(\dfrac{1}{\omega C1R}\right)^2}}=\omega C1R$$

(5) Meter Drive and Squelch

A forward bias is provided to the meter drive dedicated detector, to enable its detector diode to detect low-level signals. In addition, a bias canceler is also provided to eliminate the offsetting current in a no-signal mode created by the forward bias. Furthermore, to broaden the linear operating range, signals are fetched from the 3rd and 5th stage outputs of the limiter amp, for composition together after level detection.

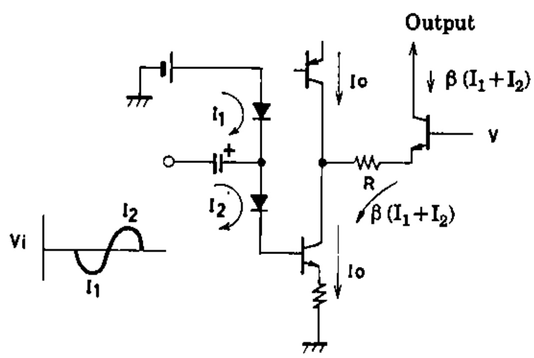


Fig.7

The composite current after the level detection flows out from pin 14, and after its being converted to a voltage by an externally connected circuit, will determine V1 of the comparator.
The squelch circuit may be provided with hysteresis by providing a resistor feedback from pin 15 to pin 14.

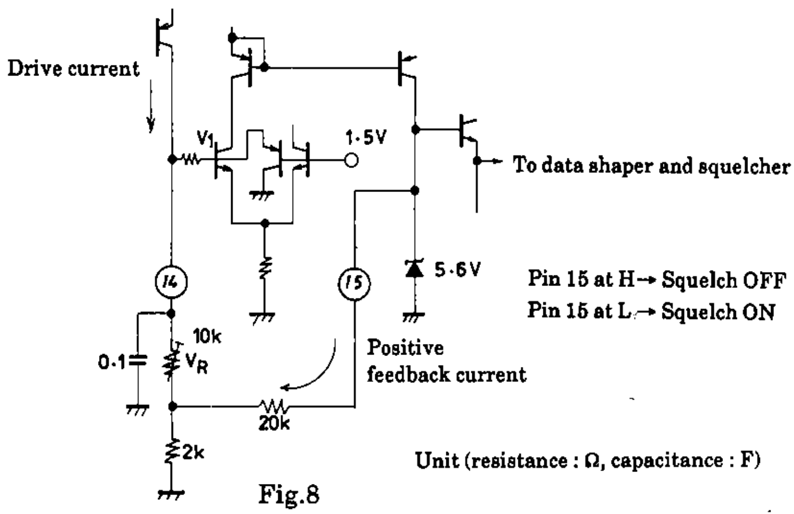


Fig.8

(6) Data Shaper
The data shaper is a high-impedance input differential amplifier that provides an open-collector output. It serves to facilitate the design for matching with a following stage (such as a CPU).

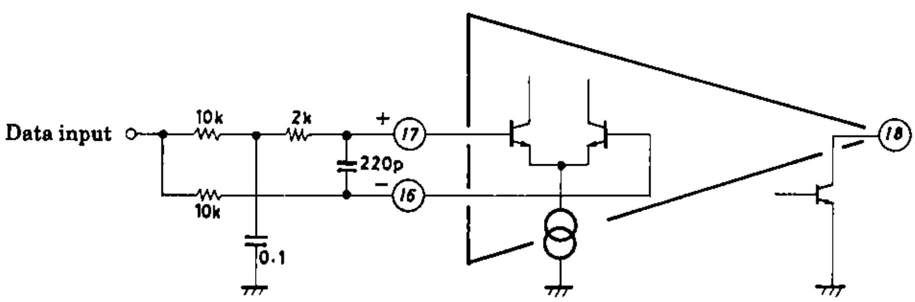


Fig.9

Unit (resistance : Ω, capacitance : F)