National Semiconductor Corporation

LM3189 FM IF System

General Description

The LM3189N is a monolithic integrated circuit that provides all the functions of a comprehensive FM IF system. The block diagram of the LM3189N includes a three stage FM IF amplifier/limiter configuration with level detectors for each stage, a doubly balanced quadrature FM detector and an audio amplifier that features the optional use of a muting (squelch) circuit.

The advanced circuit design of the IF system includes desirable deluxe features such as programmable delayed AGC for the RF tuner, an AFC drive circuit, and an output signal to drive a tuning meter and/or provide stereo switching logic. In addition, internal power supply regulators maintain a nearly constant current drain over the voltage supply range of +8.5V to +16V.

The LM3189N is ideal for high fidelity operation. Distortion in an LM3189N FM IF system is primarily a function of the phase linearity characteristic of the outboard detector coil.

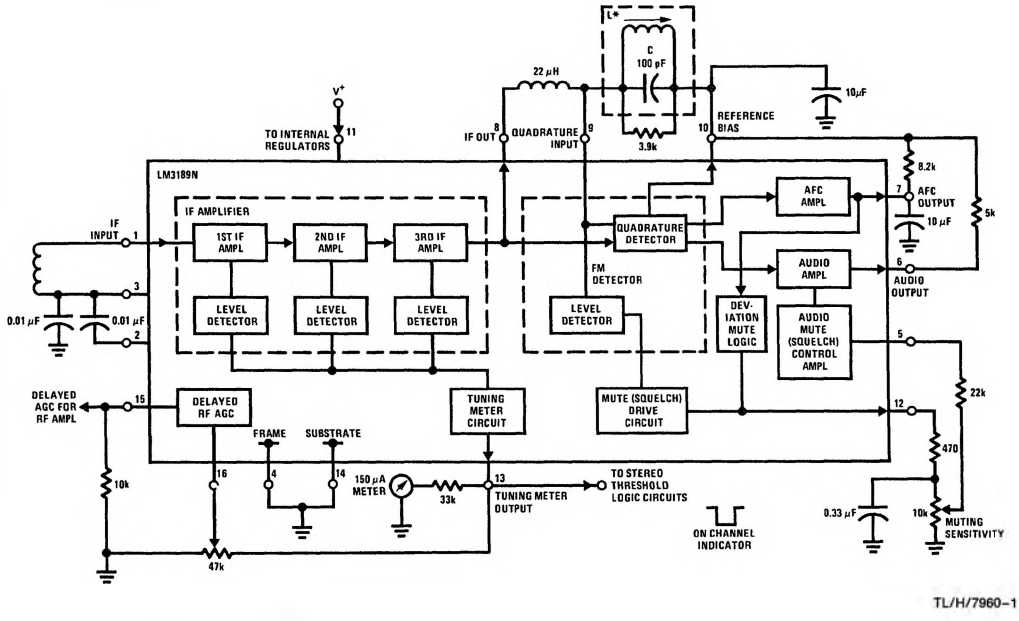
The LM3189N has all the features of the LM3089N plus additions.

The LM3189N utilizes the 16-lead dual-in-line plastic package and can operate over the ambient temperature range of −40°C to +85°C.

Features

- Exceptional limiting sensitivity: 12 μV typ at −3 dB point
- Low distortion: 0.1% typ (with double-tuned coil)
- Single-coil tuning capability
- Improved (S + N)/N ratio
- Externally programmable recovered audio level
- Provides specific signal for control of inter-channel muting (squelch)
- Provides specific signal for direct drive of a tuning meter
- On channel step for search control
- Provides programmable AGC voltage for RF amplifier
- Provides a specific circuit for flexible audio output
- Internal supply voltage regulators
- Externally programmable ON channel step width, and deviation at which muting occurs

Block Diagram



TL/H/7960–1

All resistance values are in Ω

*L tunes with 100 pF (C) at 10.7 MHz, $Q_0 \cong 75$
(Toko No. KACS K586HM or equivalent)

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage Between Pin 11 and Pins 4, 14	16V
DC Current Out of Pin 12	5 mA
DC Current Out of Pin 13	5 mA
DC Current Out of Pin 15	2 mA
Power Dissipation (Note 2)	1500 mW
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	260°C

Electrical Characteristics $T_A = 25°C, V^+ = 12V$

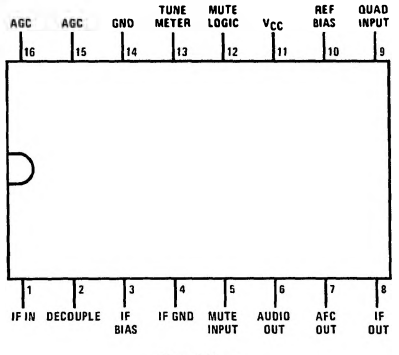
Symbol	Parameter	Conditions (See Single-Tuned Test Circuit)		Min	Typ	Max	Units
STATIC (DC) CHARACTERISTICS							
I_{11}	Quiescent Circuit Current			20	31	44	mA
	DC Voltages:						
V1	Terminal 1 (IF Input)	No Signal Input, Non Muted		1.2	2.0	2.4	V
V2	Terminal 2 (AC Return to Input)			1.2	2.0	2.4	V
V3	Terminal 3 (DC Bias to Input)			1.2	2.0	2.4	V
V15	Terminal 15 (RF AGC)			7.5	9.5	11	V
V10	Terminal 10 (DC Reference)			5	5.75	6	V
DYNAMIC CHARACTERISTICS							
V_I(lim)	Input Limiting Voltage (−3 dB Point)				12	25	μV
AMR	AM Rejection (Term. 6)	V_{IN} = 0.1V		45	55		dB
V_O(AF)	Recovered AF Voltage (Term. 6)	AM Mod. = 30%	f_O = 10.7 MHz, f_{mod} = 400 Hz, Deviation ±75 kHz	325	500	650	mV
THD	Total Harmonic Distortion (Note 1)						
	Single Tuned (Term. 6)	V_{IN} = 0.1V			0.5	1	%
	Double Tuned (Term. 6)				0.1		%
S + N/N	Signal Plus Noise to Noise Ratio (Term. 6)			65	80		dB
f_{DEV}	Deviation Mute Frequency		f_{mod} = 0		±40		kHz
V16	RF AGC Threshold				1.25		V
V12	On Channel Step	V_{IN} = 0.1V	f_{DEV} < ±40 kHz		0		V
			f_{DEV} > ±40 kHz		5.6		

Note 1: THD characteristics are essentially a function of the phase characteristics of the network connected between terminals 8, 9, and 10.

Note 2: For operation in ambient temperatures above 25°C, the device must be derated based on a 150°C maximum junction temperature and a thermal resistance of 80°C/W junction to ambient.

Connection Diagram

Dual-In-Line Package



TL/H/7960–2

Top View

Order Number LM3189N
See NS Package Number N16E

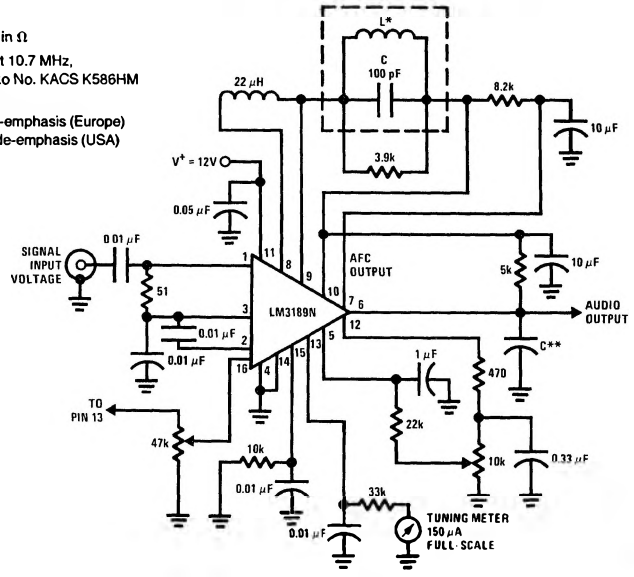
Test Circuits

Test Circuit for LM3189N Using a Single-Tuned Detector Coil

All resistance values are in Ω

*L tunes with 100 pF (C) at 10.7 MHz, Q_o(unloaded) ≅ 75 (Toko No. KACS K586HM or equivalent)

**C = 0.01 μF for 50 μs de-emphasis (Europe)
= 0.015 μF for 75 μs de-emphasis (USA)



TL/H/7960–3

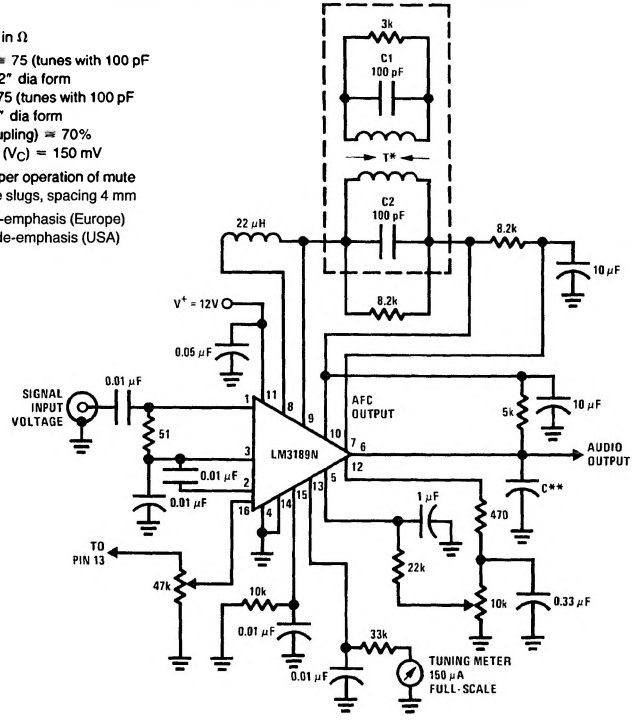
Test Circuit for LM3189N Using a Double-Tuned Detector Coil

All resistance values are in Ω

'T:PRI—Q_o(unloaded— ≅ 75 (tunes with 100 pF (C12)) 20t of 34e on 7/32" dia form
SEC—Q_o(unloaded) ≅ 75 (tunes with 100 pF (C2)) 20t of 34e on 7/32" dia form
kQ(percent of critical coupling) ≅ 70%
(adjusted for coil voltage (V_C) = 150 mV

Above values permit proper operation of mute (squelch) circuit "E" type slugs, spacing 4 mm

**C = 0.01 μF for 50 μs de-emphasis (Europe)
= 0.015 μF for 75 μs de-emphasis (USA)

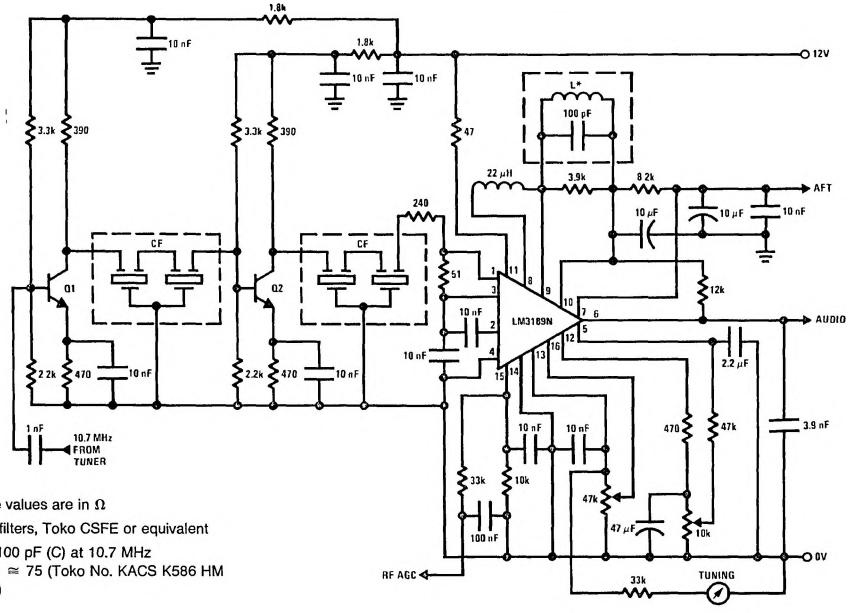


TL/H/7960–4

Complete FM IF System for High Quality Tuners

The circuit provides a complete FM IF system for a high quality receiver. Either one or two stages of amplification and bandpass filtering may be desired, depening on the receiver requirements. See graph for Typical Limiting and Noise Characteristics for each circuit configuration which can be compared to the LM3189N alone.

Complete FM IF System for High Quality Receivers



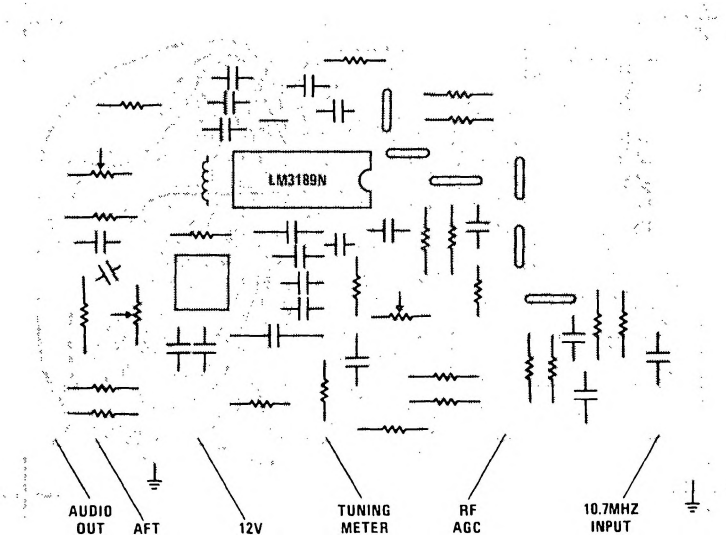
All resistance values are in Ω

CF: Ceramic filters, Toko CSFE or equivalent

*L tunes with 100 pF (C) at 10.7 MHz
Q_O(unloaded) ≅ 75 (Toko No. KACS K586 HM or equivalent)

TL/H/7960–5

Printed Circuit Board and Component Layout

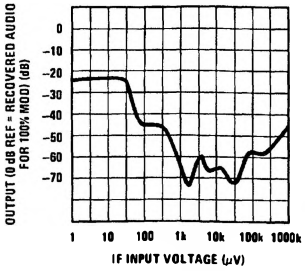


TL/H/7960–6

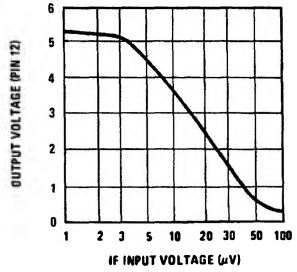
Component Side

Typical Performance Characteristics

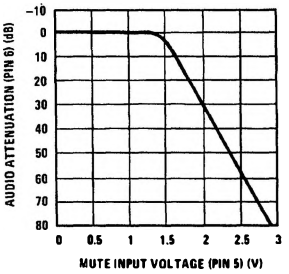
AM Rejection (30% Mod) vs IF Input Signal



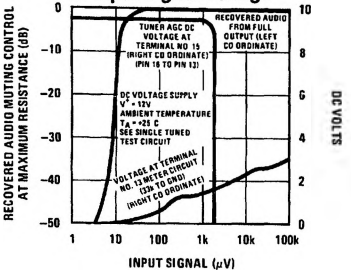
Mute Control Output (Pin 12) vs IF Input Signal



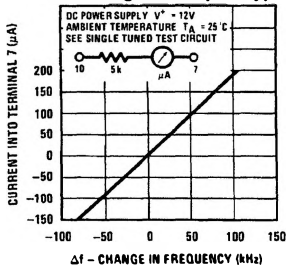
Typical Audio Attenuation (Pin 6) vs Mute Input Voltage (Pin 5)



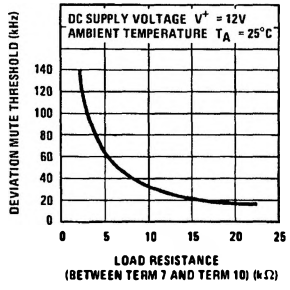
Muting Action, Tuner AGC, and Tuning Meter Output as a Function of Input Signal Voltage



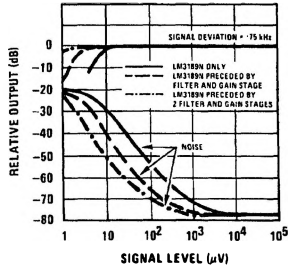
AFC Characteristics (Current at Term 7 as a Function of Change in Frequency)



Deviation Mute Threshold as a Function of Load Resistance (Between Term 7 and Term 10)

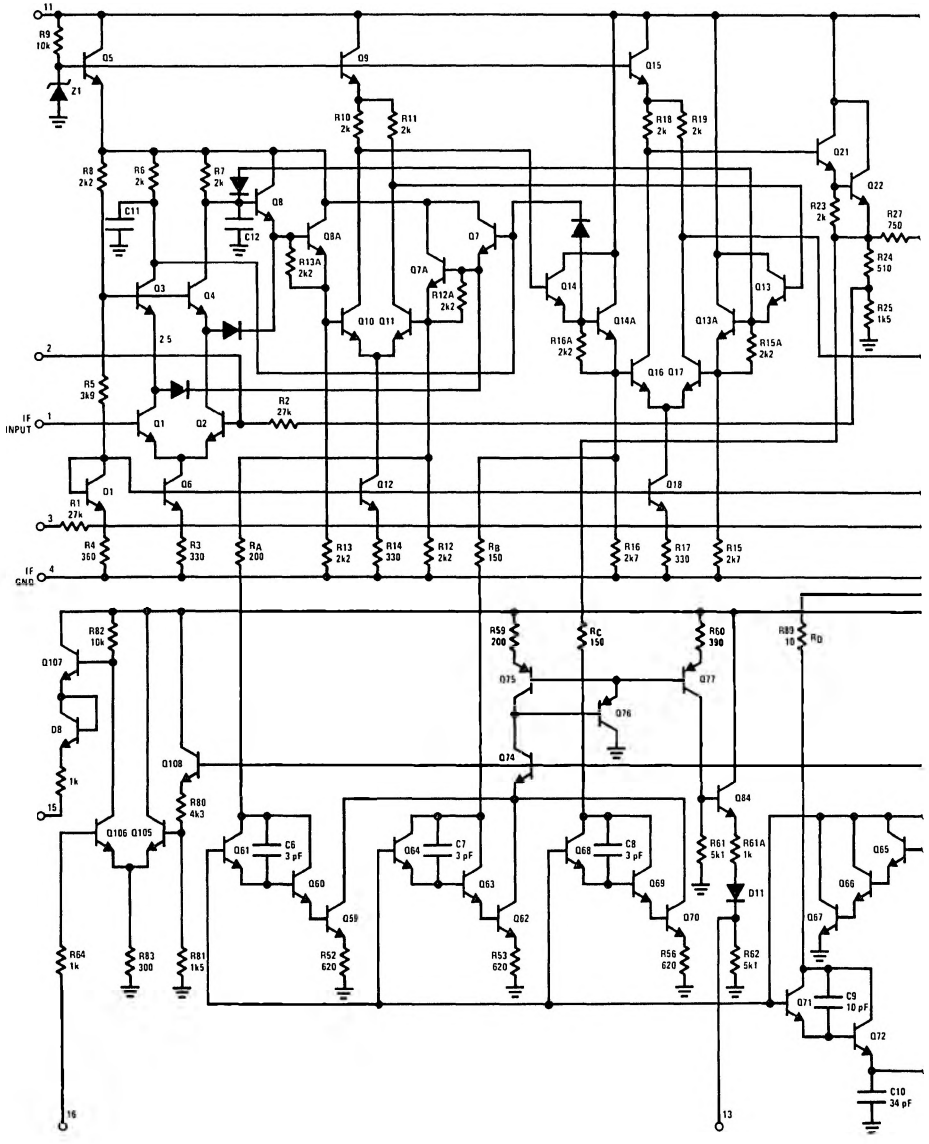


Typical Limiting and Noise Characteristics



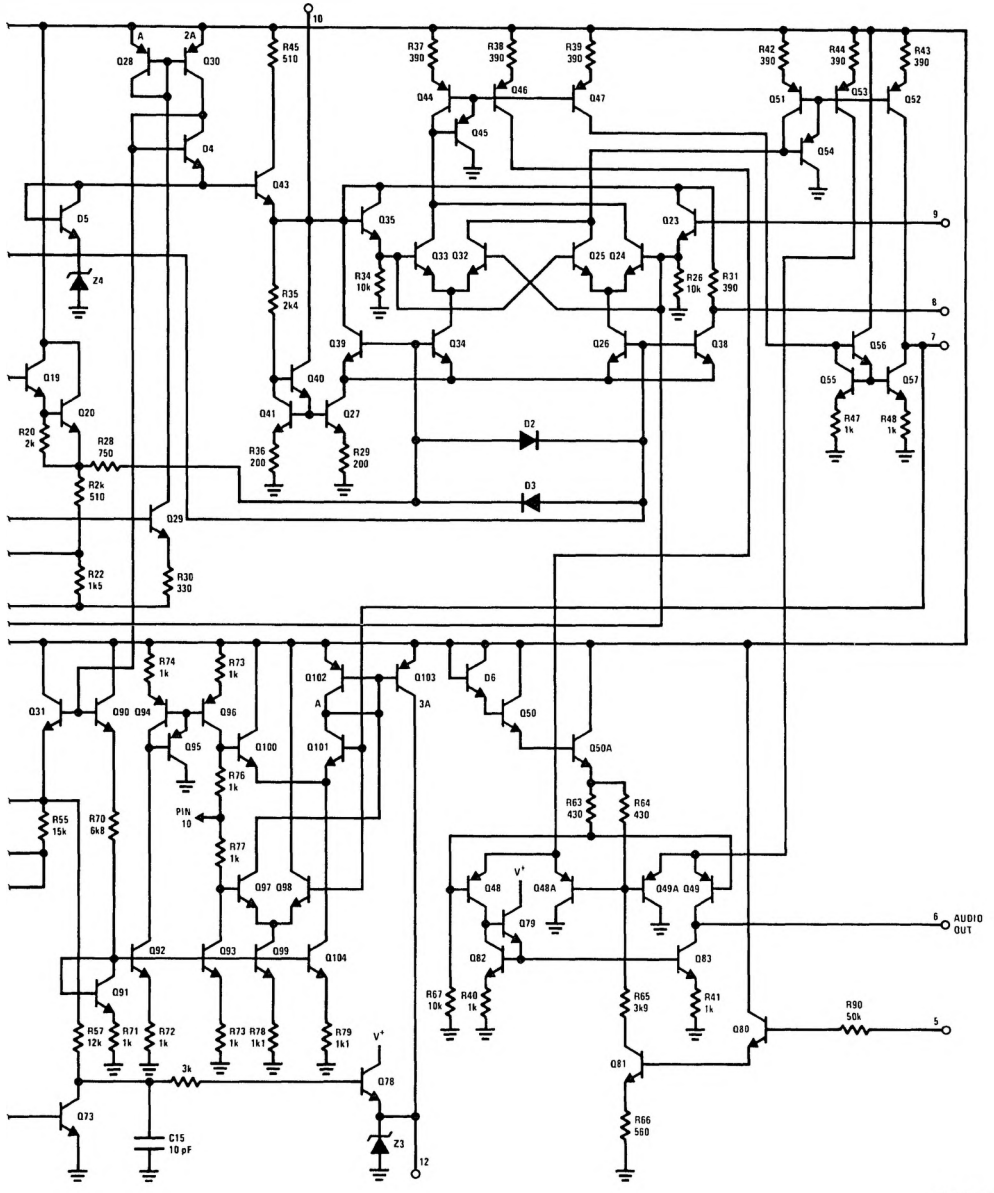
TL/H/7960–7

Schematic Diagram



TL/H/7960–8

Schematic Diagram (Continued)



TL/H/7960–9