

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.

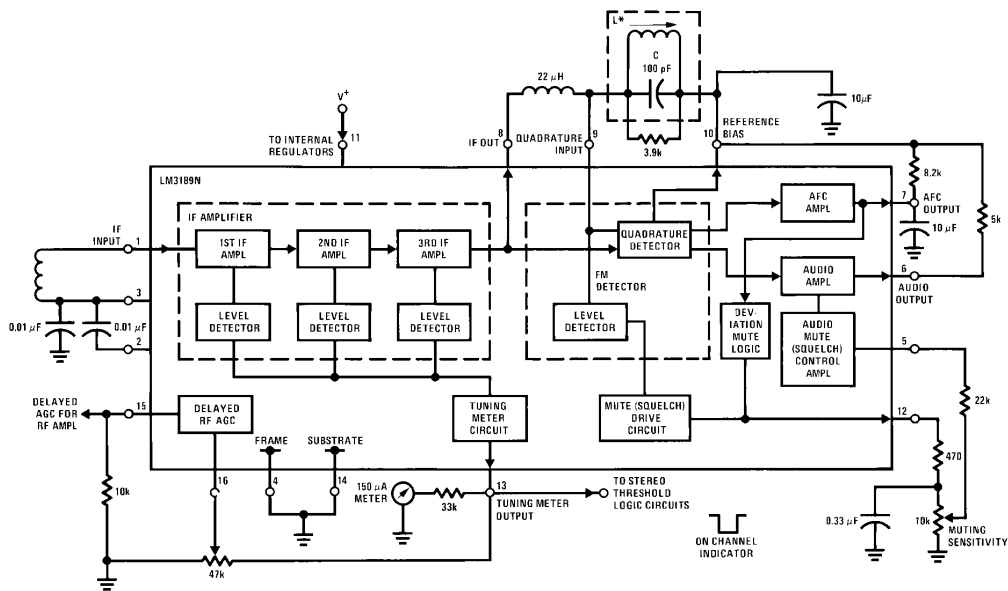
The LM3189N has all the features of the LM3089N plus additions.

The LM3189N utilizes the 16-lead dual-in-line plastic package and can operate over the ambient temperature range of -40°C to $+85^{\circ}\text{C}$.

Features

- Exceptional limiting sensitivity: $12\ \mu\text{V}$ typ at $-3\ \text{dB}$ 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 $100\ \text{pF}$ (C) at $10.7\ \text{MHz}$, $Q_0 \approx 75$
(Toko No. KACS K586HM or equivalent)

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please 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

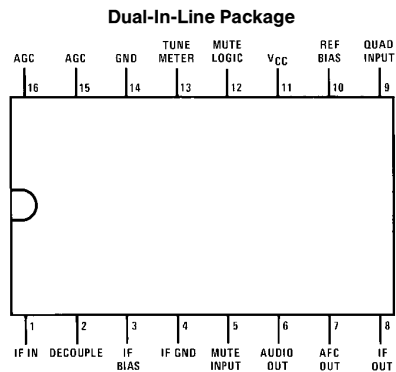
Electrical Characteristics $T_A = 25^\circ\text{C}$, $V^+ = 12\text{V}$

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

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



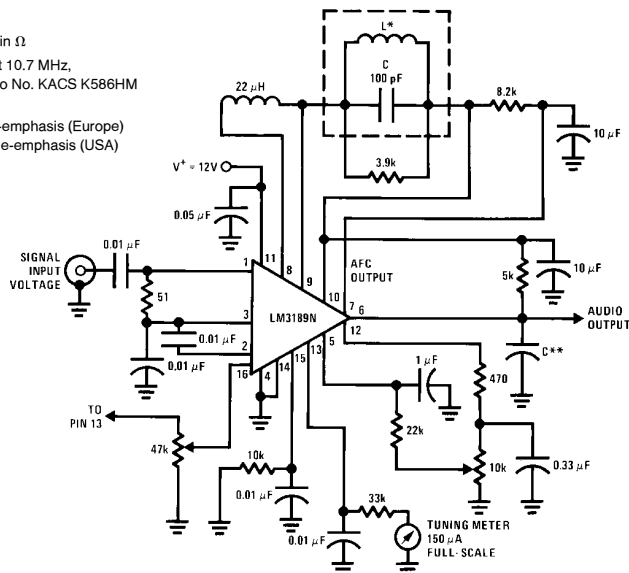
TL/H/7960-2

Order Number LM3189N
See NS Package Number N16E

Test Circuits

Test Circuit for LM3189N Using a Single-Tuned Detector Coil

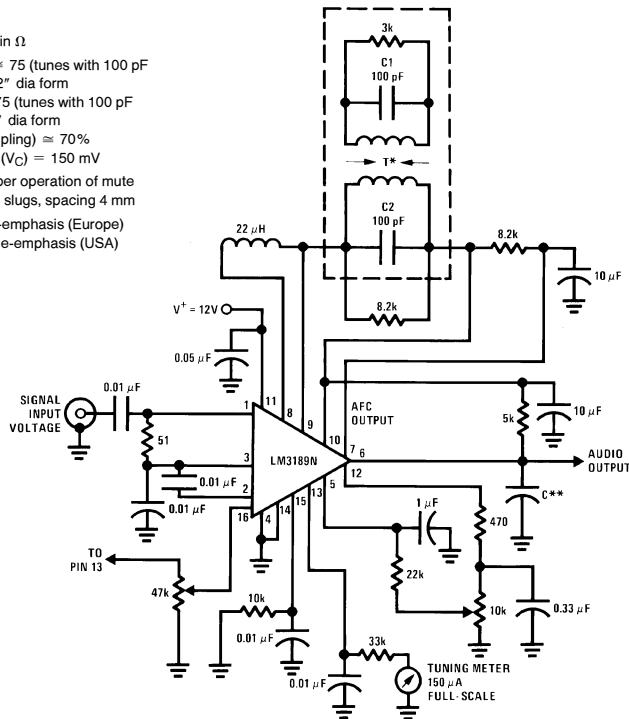
- All resistance values are in Ω
 *L tunes with 100 pF (C) at 10.7 MHz,
 $Q_0(\text{unloaded}) \approx 75$ (Toko No. KACS K586HM
 or equivalent)
 **C = 0.01 μF for 50 μs de-emphasis (Europe)
 = 0.015 μF for 75 μs de-emphasis (USA)



TL/H/7960-3

Test Circuit for LM3189N Using a Double-Tuned Detector Coil

- All resistance values are in Ω
 *T:PRI— $Q_0(\text{unloaded}) \approx 75$ (tunes with 100 pF
 (C12)) 20t of 34e on 7/32" dia form
 SEC— $Q_0(\text{unloaded}) \approx 75$ (tunes with 100 pF
 (C2)) 20t of 34e on 7/32" dia form
 $kQ(\text{percent of critical coupling}) \approx 70\%$
 (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)



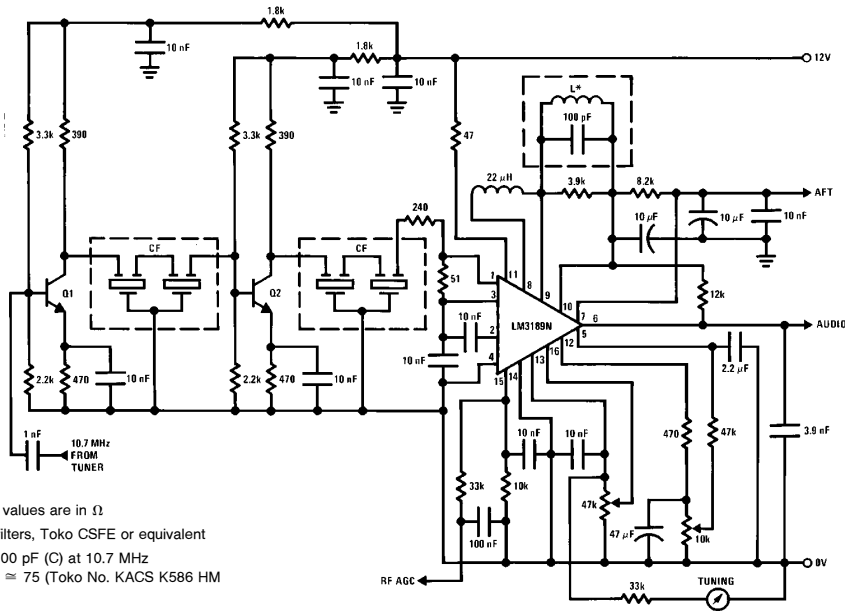
TL/H/7960-4

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, depending on the

receiver requirements. See graph for Typical Limiting and Noise Characteristics for each circuit configuration which can be compared to the LM3189N alone.

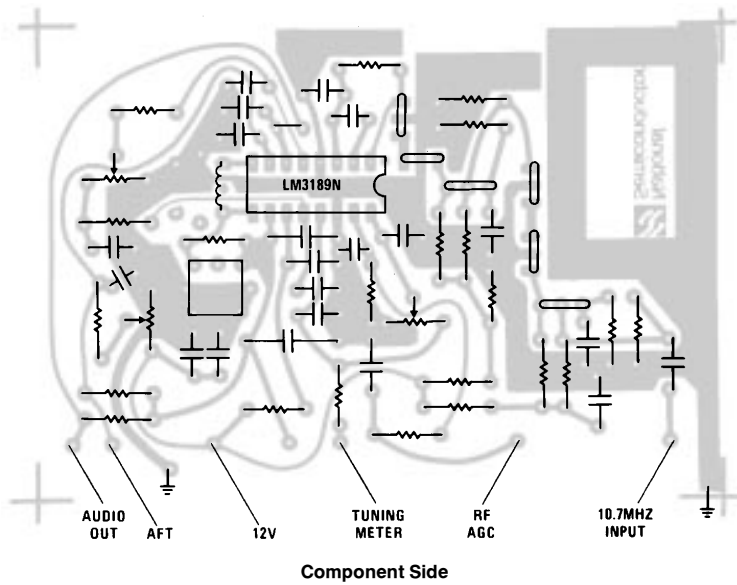
Complete FM IF System for High Quality Receivers



All resistance values are in Ω
 CF: Ceramic filters, Toko CSFE or equivalent
 *L tunes with 100 pF (C) at 10.7 MHz
 $Q_0(\text{unloaded}) \approx 75$ (Toko No. KACS K586 HM or equivalent)

TL/H/7960-5

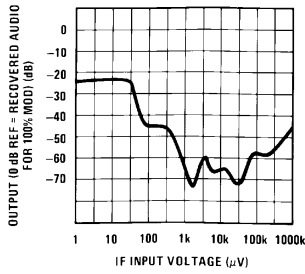
Printed Circuit Board and Component Layout



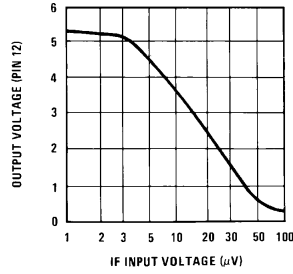
TL/H/7960-6

Typical Performance Characteristics

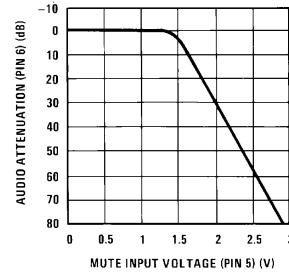
AM Rejection (30% Mod) vs IF Input Signal



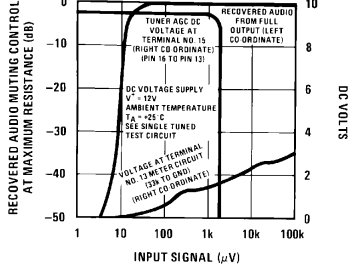
Mute Control Output (Pin 12) vs IF Input Signal



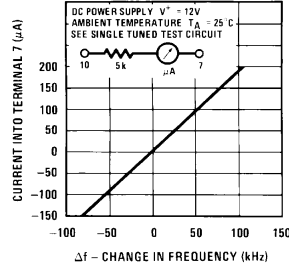
Typical Audio Attenuation (Pin 6) vs Mute Input Voltage (Pin 5)



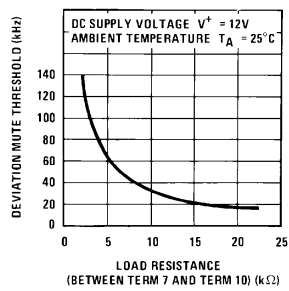
Muting Action, Tuner AGC, and Tuning Meter Output as a Function of Input Signal Voltage



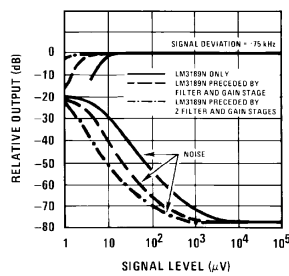
AFC Characteristics (Current at Term 7 as a Function of Change in Frequency)



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

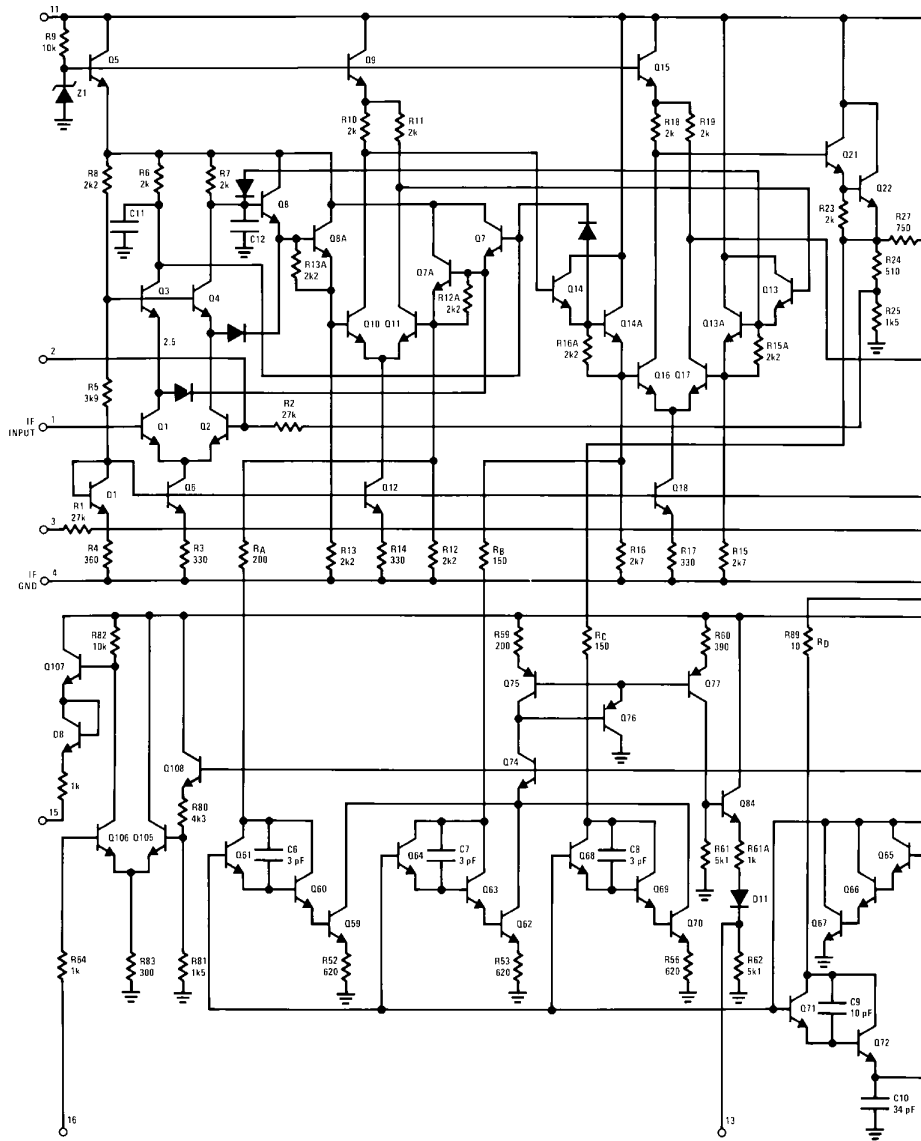


Typical Limiting and Noise Characteristics



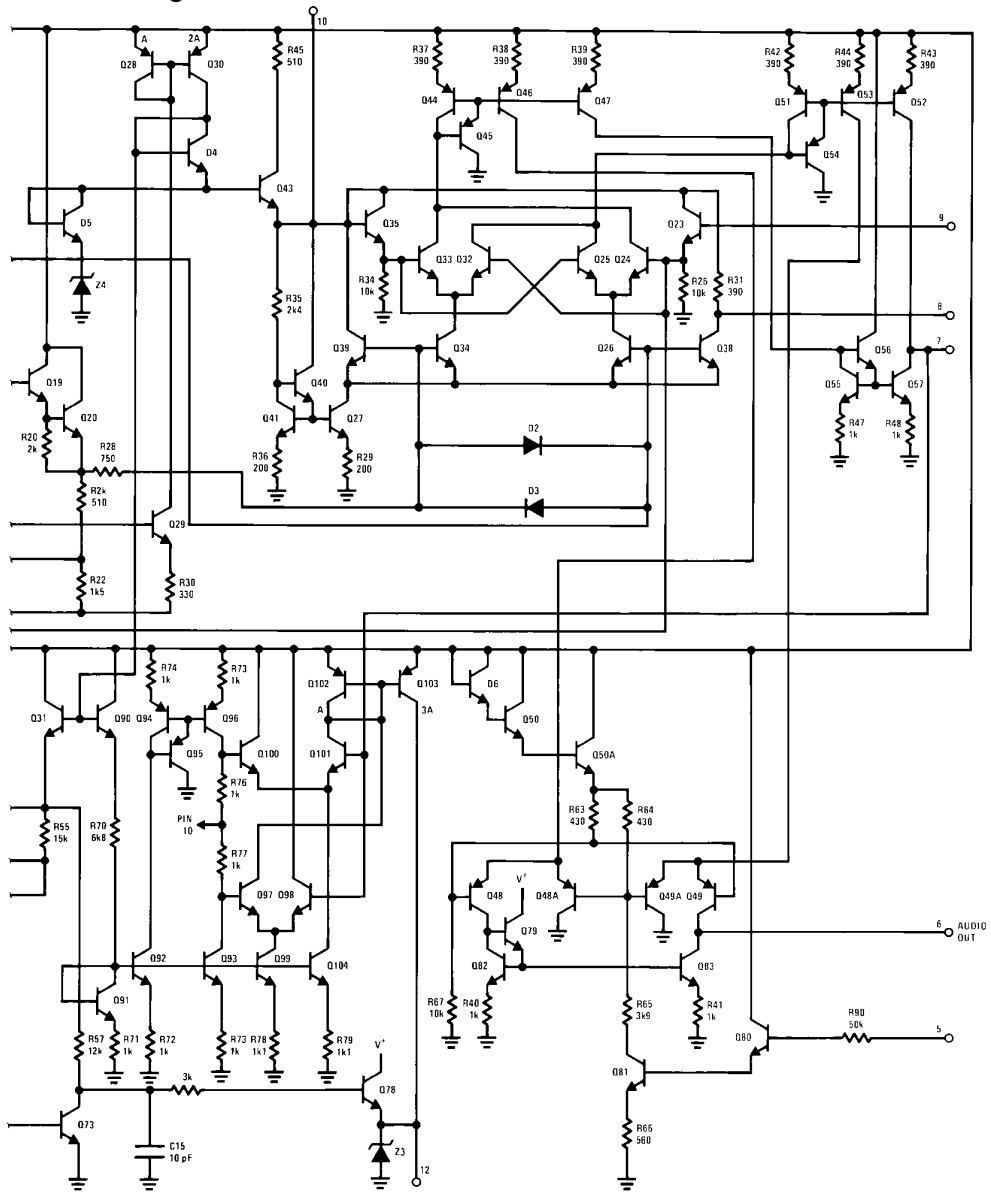
TL/H/7960-7

Schematic Diagram



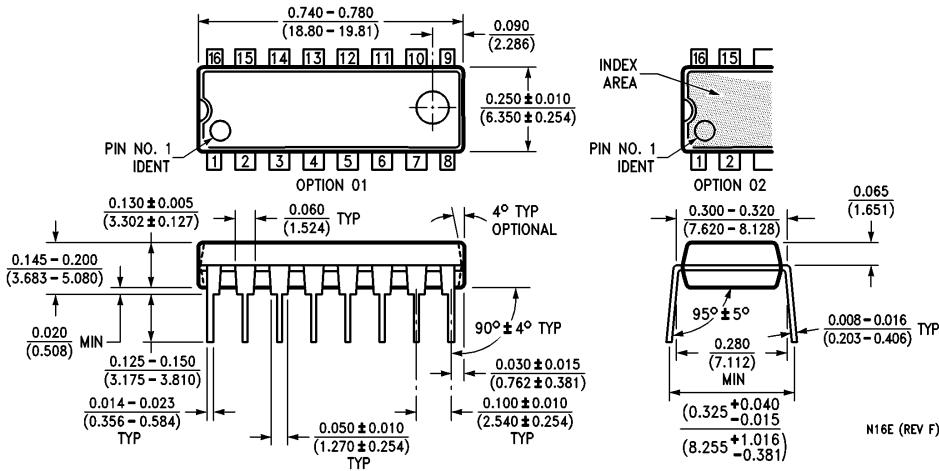
TL/H/7960-8

Schematic Diagram (Continued)



TL/H/7960-9

Physical Dimensions inches (millimeters)



Dual-In-Line Package (N)
Order Number LM3189N
See NS Package Number N16E

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



National Semiconductor Corporation
 1111 West Bardin Road
 Arlington, TX 76017
 Tel: 1(800) 272-9959
 Fax: 1(800) 737-7018

National Semiconductor Europe
 Fax: (+49) 0-180-530 85 86
 Email: cnjwge@tevm2.nsc.com
 Deutsch Tel: (+49) 0-180-530 85 85
 English Tel: (+49) 0-180-532 78 32
 Français Tel: (+49) 0-180-532 93 58
 Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
 19th Floor, Straight Block,
 Ocean Centre, 5 Canton Rd.
 Tsimshatsui, Kowloon
 Hong Kong
 Tel: (852) 2737-1600
 Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
 Tel: 81-043-299-2309
 Fax: 81-043-299-2408

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.