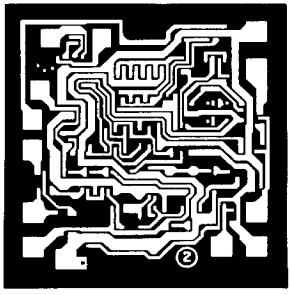
ULN-2111A F-M I-F AMPLIFIER/LIMITER AND QUADRATURE DETECTOR

FEATURES

- Good Sensitivity
- Excellent A-M Rejection
- Low Harmonic Distortion
- Single-Adjustment Tuning
- High Gain to 50 MHz
- 500 mV Recovered Audio at 10.7 MHz
- Wide Operating Voltage Range
- Direct Replacement for ULN-2113A, MC1357, SN76643
- 14-Pin Dual In-Line Plastic Package



PROVIDING a multistage wideband amplifier/limiter, an F-M quadrature detector, and an emitter-follower audio output stage, the Type ULN-2111A is designed for use in F-M receivers or in the sound I-F of TV receivers.

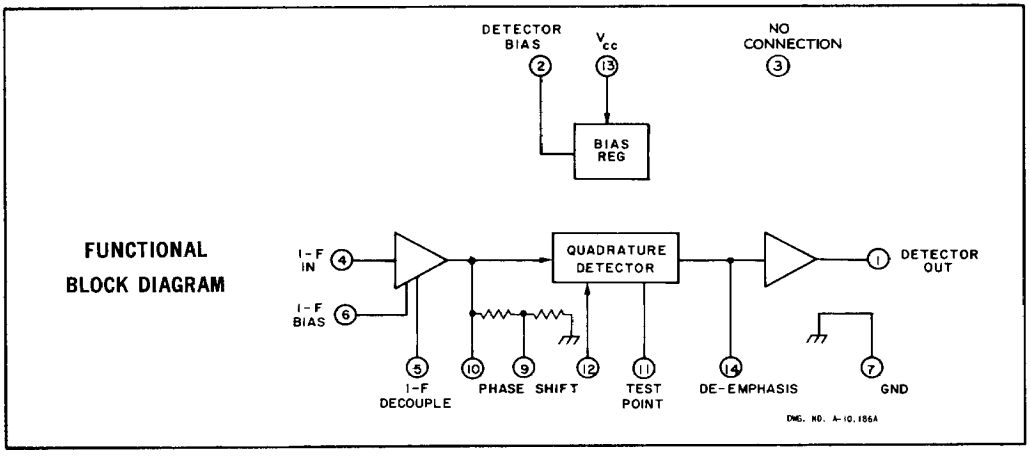
The Type ULN-2111A amplifier/limiter and quadrature detector is a Sprague-originated design. This circuit was the original monolithic integrated circuit F-M detector and was the first integrated circuit to be used in entertainment electronics. Its outstanding feature is that only a single low-cost tuned circuit is required instead of the previous triple-winding transformer.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC} . . . . . 15 V
Package Power Dissipation, P_D . . . . . 670 mW*
Operating Temperature Range, T_A . . . . . −20°C to +85°C
Storage Temperature Range, T_S . . . . . −65°C to +150°C

*Derate at the rate of 8.3 mW/°C above T_A = +70°C.

FUNCTIONAL BLOCK DIAGRAM



STATIC ELECTRICAL CHARACTERISTICS at $T_A = +25°C$, $V_{CC} = +12$ V

Characteristic	Symbol	Test Pin	Test Conditions	Limits Min.	Typ.	Max.	Units
Supply Current	I_{CC}	13		12	17	27	mA
Terminal Voltage	V_1	1		4.3	5.7	7.2	V
	V_2	2		—	3.65	—	V
	V_6	6		—	1.45	—	V
	V_9	9		—	150	—	mV
	V_{10}	10		—	1.45		V
Resistance, Detector Output	R_1	1		—	200	—	Ω
I-F Input	R_4	4		—	5.0	—	kΩ
I-F Output	R_{10}	10		—	60	—	Ω
Detector Input	R_{12}	12		—	70	—	kΩ
De-Emphasis	R_{14}	14		6.0	9.0	12	kΩ
Capacitance, I-F Input	C_4	4		—	11	—	pF
Detector Input	C_{12}	12		—	2.7	—	pF

DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A = +25°C$, $V_{CC} = +12$ V, $f_o = 10.7$ MHz, $f_m = 400$ Hz, $\Delta f = \pm 75$ kHz, Peak Separation = 550 kHz

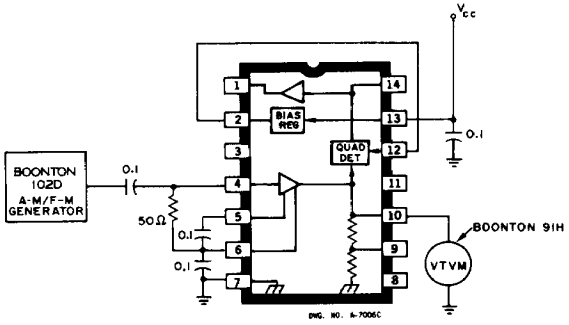
Characteristic	Symbol	Test Pin	Test Figure	Test Conditions	Limits Min.	Typ.	Max.	Units	Notes
Amplifier Voltage Gain	A_e	10	1	$V_{in} \leq 300\ \mu V_{rms}$	—	53	—	dB	
Amplifier Output Voltage	V_{out}	10	1	$V_{in} = 10\ mV_{rms}$	—	1.45	—	V_{pp}	
Input Limiting Threshold	V_{th}	4	2		—	400	800	μV_{rms}	1, 3
Recovered Audio Output	V_{out}	1	2	$V_{12} = 60\ mV_{rms}$	—	500	—	mV_{rms}	3
Output Distortion	THD	1	2	100% F-M Modulation	—	1.0	—	%	3
A-M Rejection	AMR	1	3	$V_{in} = 10\ mV_{rms}$	—	40	—	dB	2

NOTES:

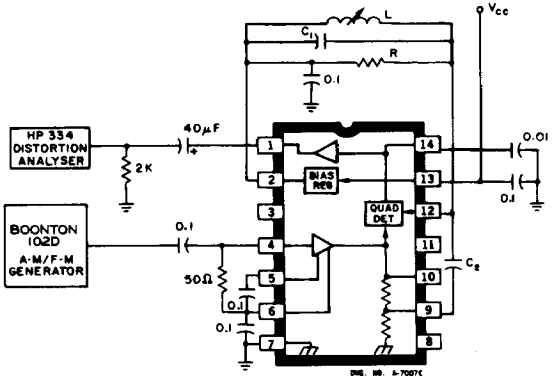
1. The input limiting threshold is the F-M input voltage for a recovered audio output which is 3 dB less than the recovered audio output for an F-M input voltage of 200 mV_{rms}.
2. The amplitude modulation rejection is determined by: $AMR_{db} = 20 \log \frac{V_{out} \text{ for 100\% F-M } V_{in}}{V_{out} \text{ for 30\% A-M } V_{in}}$
3. See also, General Design Note No. 9.

COMPONENT CHART

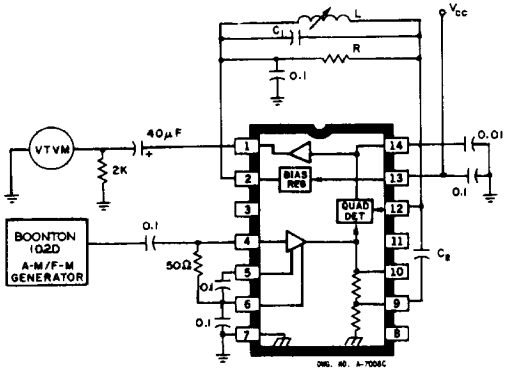
	Component Value TV (4.5 MHz)	F-M (10.7 MHz)
L—Inductance	7.0 - 14 μH	1.5 - 3.0 μH
Unloaded Q	50	50
D-C Resistance	<50Ω	<50Ω
Type	Miller #9052	Miller #9050
C_1—Capacitance	120 pF	120 pF
TCC	NPO	NPO
C_2—Capacitance	3.0 pF	4.7 pF
R—Resistance	20 kΩ	3.9 kΩ
Loaded Network Q	30	20



TEST FIGURE 1

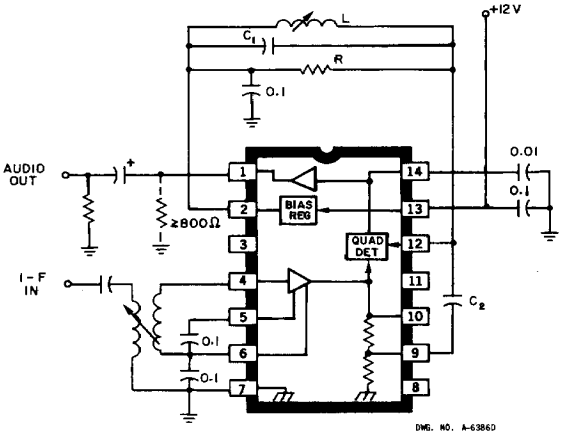


TEST FIGURE 2

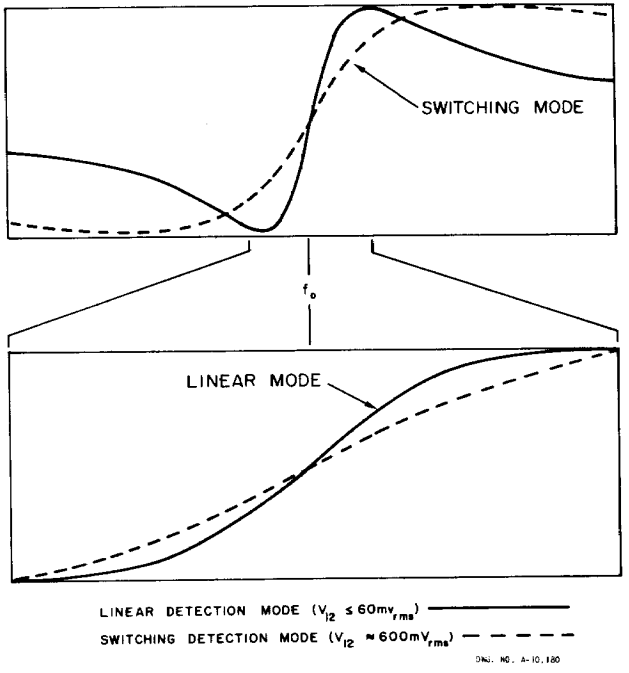


TEST FIGURE 3

TYPICAL APPLICATION



TRANSFER CHARACTERISTICS



GENERAL DESIGN NOTES

1. Phase shift network is aligned by applying F-M signal through decoupling network to pin 4 (V_4 = 5 mV_{rms}). Tune for maximum recovered audio at pin 1 or maximum I-F voltage at pin 11.
2. A d-c path of less than 100 Ω must be provided between pins 2 and 12. No other biasing provisions are required.
3. A d-c path of less than 300 Ω must be provided between pins 4 and 6. No other biasing provisions are required.
4. The maximum a-c load current can be increased by adding an external resistor between pin 1 and ground. The minimum value for this resistor is 800 Ω, giving a maximum load current of 4 mA_{rms}.
5. All decoupling capacitors should be of the ceramic type with minimum inductance at the operating frequency.
6. Decoupling capacitor leads at pins 2, 5, and 6 should be as short as possible.
7. Keep appropriate distance between the input (pin 4 and the input network) and the phase shift network (pins 9, 10, and 12, and the phase shift inductor).
8. If a high impedance power supply is used (voltage dropping resistor), decouple pin 13 for the lowest audio frequency.
9. The linear detection mode (low signal level at pin 12), as shown, is preferred for communications and other commercial applications, due to the preservation of the tuned circuit bandwidth and better rejection of Gaussian noise. The combination of coupling capacitor (C_2) and I-F amplifier output (pin 9) was chosen for optimum quieting. The bandwidth of the phase shift network (peak separation) is primarily defined by the Damping resistor (R). A higher value resistor will decrease bandwidth, increase the recovered audio output, reduce the capture ratio, and increase harmonic distortion.
10. The switching detection mode (high signal level at pin 12) features a greater linear range, increased insensitivity to amplitude variations, and is recommended for AFC applications or where side responses must be avoided. Limiting in the quadrature detector will produce slightly more audio output, but will increase the noise bandwidth and degrade quieting.

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I-F AMPLIFIER GAIN AS A FUNCTION OF FREQUENCY