# Consumer Circuits

## LM273/LM373 am/fm/ssb if amp/detector
## LM274/LM374 am/fm/ssb if video amp/detector

### general description

The LM273/LM373 and LM274/LM374 are broadband communications subsystems, capable of performing the diverse functions required in AM, FM or single sideband receivers and transmitters. In addition, the LM274/LM374 may operate as high gain AGC'd video amplifier. Bandpass shaping may be performed by a single external filter, connected between amplifier sections, at frequencies from audio up to 30 MHz. The first section of the LM273/LM373 is optimized to drive low impedance loads, such as mechanical or ceramic filters. The LM274/LM374 has a high output impedance, ideal for high-Z crystal, LC or ceramic filters.

The LM273 and LM274 are specified for operation over the −25°C to +100°C military temperature range. The LM373 and LM374 are specified for operation over the 0°C to +70°C temperature range.

### features

**CONNECTED FOR AM OPERATION**

- High gain; typical sensitivity of 10 μV at 455 kHz
- Wide bandwidth; 30 MHz capability
- Self-contained detector and AGC system
- Wide AGC range, greater than 60 dB for a 10 dB output change at 27 MHz
- Less than ±1 dB change in audio output −20°C to +100°C, typically
- Access to detector input for S/N improvement
- No DC paths required through external filters
- Low feedthrough between amplifier sections, typically better than 65 dB

**CONNECTED FOR FM OPERATION**

- Three emitter coupled limiting stages and simple quadrature detector
- Detection of ±5 kHz deviation FM at either 455 kHz or 10.7 MHz
- Two separated amplifier blocks, allowing filtering in two or more blocks
- No DC paths required through external filters or through quadrature network

**CONNECTED FOR SSB OPERATION**

- Double balanced product detector
- Self contained audio peak AGC system
- Easy external tailoring of AGC characteristic for desired AGC figure of merit

**CONNECTED FOR VIDEO AMPLIFIER OPERATION**

- Internal video peak detector for video AGC
- High and low level video outputs
- Gated video AGC capability

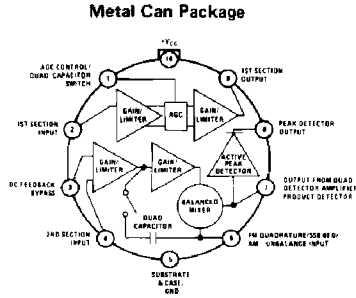
In addition, these versatile microcircuits may be used as:

- Constant amplitude or amplitude modulated RF oscillator
- Synchronous demodulating IF strip
- Mixer and IF, using AGC section as a mixer
- Double sideband modulator with audio AGC



### connection diagrams

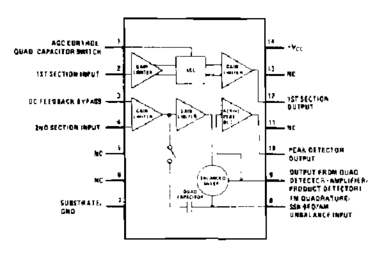
**Metal Can Package**



TOP VIEW

**Order Number LM273H or LM373H**
**LM274H or LM374H**
**See Package 14**

**Dual-In-Line Package**



TOP VIEW

**Order Number LM373N or LM374N**
**See Package 22**

## absolute maximum ratings

| | |
|---|---|
| Supply Voltage, Operating | 18V |
| Supply Voltage, Surge (100 ms max) | 24V |
| AC Voltage Applied to Any Pin | $1.4V_{p\text{-}p}$ |
| DC Voltage Applied to AGC Section Output Pin | |
| LM273/LM373 | +10V, −0.5V |
| LM274/LM374 | +18V, −0.5V |
| DC Voltage Applied to Any Other Pin | +8V, −0.5V |
| Junction Temperature (Note 1) | 150°C |
| Storage Temperature Range | −65°C to +150°C |
| Operating Temperature Range | |
| LM273, LM274 | −25°C to +100°C |
| LM373, LM374 | 0°C to +70°C |

## electrical characteristics

($T_A$ = 25°C, $V_{CC}$ = +12V unless otherwise noted) (Subscript numbers in parentheses are DIP pin numbers)

**DC CHARACTERISTICS**

| PARAMETER | SYMBOL | CONDITIONS | LM273/LM274 | | | LM373/LM374 | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Power Supply Current | $I_{10(14)}$ | $V_{CC}$ = 12V, AM Mode | | 14 | 20 | | 14 | 20 | mA |
| | | $-20°C \leq T_A \leq +100°C$ | | | 21 | | | | mA |
| AGC Input Current | $I_1$ | $V_{AGC} \leq 5V$ | | 50 | 110 | | 50 | 110 | μA |
| | | $-20°C \leq T_A \leq +100°C$ | | | 110 | | | | μA |
| AGC Section Quiescent Output | $V_{9(12)}$ | $V_{AGC}$ = 0V, LM273/LM373 | | 4.75 | | | 4.75 | | V |
| | $I_{9(12)}$ | $V_{AGC}$ = 0V, LM274/LM374 | 0.5 | 0.7 | 1.0 | 0.5 | 0.7 | 1.0 | mA |
| AGC Section Output Shift | | $V_{AGC}$ = 0V to $V_{AGC}$ = 5V | | | | | | | |
| | $\Delta V_{9(12)}$ | LM273/LM373 | | 0.1 | | | 0.1 | | V |
| | $\Delta I_{9(12)}$ | LM274/LM374 | | −0.1 | | | −0.1 | | mA |
| Second Section Quiescent Output Voltage | $V_{7(9)}$ | | | 3.8 | | | 3.8 | | V |
| Peak Detector Quiescent Output Voltage | $V_{8(10)}$ | | | 3.8 | | | 3.8 | | V |

**VIDEO CHARACTERISTICS**

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| AGC Section Voltage Gain | $A_{2-9(11)}$ | $V_{AGC}$ = 0V, f = 455 kHz | 30 | 32 | | 29 | 32 | | dB |
| | | $V_{AGC}$ = 4.5V | | | −40 | | | −40 | dB |
| | | $-20°C \leq T_A \leq 100°C$ LM273/LM373 | 28 | | | | | | dB |
| AGC Section Transconductance | $g_{m2-9(11)}$ | $V_{AGC}$ = 0V, f = 455 kHz | 28 | 40 | | 28 | 40 | | mmhos |
| | | $-20°C \leq T_A \leq 100°C$ LM274/LM374 | 28 | | | | | | mmhos |
| AGC Section Bandwidth | $BW_{AGC}$ | $Z_L$ = 1k‖3 pF | | 30 | | | 30 | | MHz |
| AGC Section Output Swing | $V_{9(12)}\ max_{p\text{-}p}$ | $R_L$ = 1k, $V_{AGC}$ = 0V, $V_2$ = ±300 mV, | 0.95 | 1.4 | | 0.78 | 1.4 | | $V_{p\text{-}p}$ |
| | | $-20°C \leq T_A \leq 100°C$ | 0.7 | | | | | | $V_{p\text{-}p}$ |
| AGC Section Conversion Voltage Gain | $A_{C,AGC}$ | $f_1$ = 30 MHz, $f_2$ = 30.455 MHz, $e_2$ = 800 mVrms (See Figure 8) | | 22 | | | 22 | | dB |
| Second Section Voltage Gain | $A_{4-7(11)}$ | f = 455 kHz | 32.5 | 37 | 39 | 29.5 | 37 | – | dB |
| | | $T_A$ = 100°C | | 31 | | | | | |
| Second Section Bandwidth | $BW_2$ | $Z_L$ = 100k‖3 pF | | 20 | | | 20 | | MHz |
| Second Section Output Swing | $V_{7(11)}\ max_{p\text{-}p}$ | $V_{3-4}$ = ±100 $mV_{p\text{-}p}$ | 0.93 | 1.4 | | .83 | 1.4 | | $V_{p\text{-}p}$ |
| | | $-20°C \leq T_A \leq 100°C$ | 0.75 | | | | | | $V_{p\text{-}p}$ |

**AC PORT PARAMETERS** (Typical, $e_{IN}$ = 20 mVrms)

| TERMINAL | LM273/LM373 | | | LM274/LM374 | | |
|---|---|---|---|---|---|---|
| | f = 455 kHz | f = 10.7 MHz | f = 27 MHz | f = 455 kHz | f = 10.7 MHz | f = 27 MHz |
| 2 ($V_{AGC}$ = 0V) | 1.2k ‖ 2.5 pF | 1.2k ‖ 2.5 pF | 1.15k ‖ 2.6 pF | 1.2k ‖ 2.5 pF | 1.2k ‖ 2.5 pF | 1.15k ‖ 2.6 pF |
| 2 ($V_{AGC}$ = 5V) | 1.18k ‖ 3 pF | 1.18k ‖ 3 pF | 1.1k ‖ 2.7 pF | 1.18k ‖ 3 pF | 1.18k ‖ 3 pF | 1.1k ‖ 2.7 pF |
| 4 | 4.5k ‖ 4 pF | 5k ‖ 5 pF | 4.3k ‖ 5.5 pF | 4.5k ‖ 4 pF | 5k ‖ 5 pF | 4.3k ‖ 5.5 pF |
| 6(8) | 3.0k ‖ 7.7 pF | 3.0k ‖ 7.7 pF | 3.0k ‖ 8.0 pF | 3.0k ‖ 7.7 pF | 3.0k ‖ 7.7 pF | 3.0k ‖ 8.0 pF |
| 7(9) | 1.0k ‖ 6 pF | 1.0k ‖ 6 pF | 1.0k ‖ 5 pF | 1.0k ‖ 6 pF | 1.0k ‖ 6 pF | 1.0k ‖ 5 pF |
| 9(12) | 70Ω ‖ −100 pF | 60Ω ‖ 5 pF | 200Ω ‖ −90 pF | 600k ‖ 5.5 pF | 100k ‖ 3.3 pF | 10k ‖ 3.5 pF |

**Note 1:** For operation at elevated temperatures, derate devices based on 150°C maximum junction temperature and 150°C/W junction to ambient or 45°C/W junction to case thermal coefficients for the metal can.

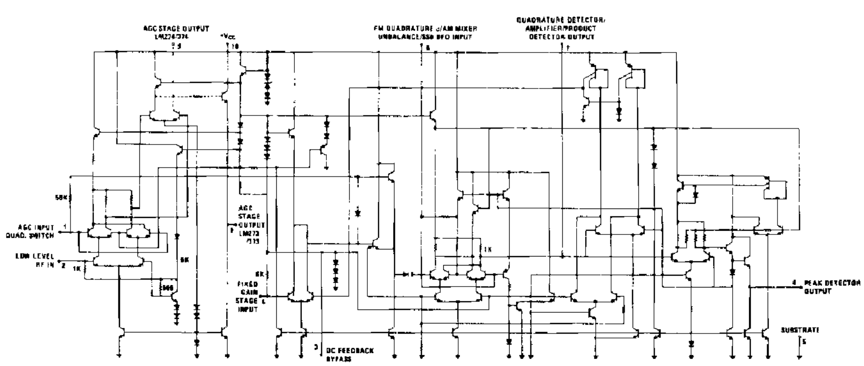
## electrical characteristics (con't)

**TYPICAL AM PERFORMANCE** (See Figures 1 and 2)

| PARAMETER | CONDITIONS | f = 455 kHz | f = 10.7 MHz | f = 27 MHz | UNITS |
|---|---|---|---|---|---|
| Sensitivity | (Signal + Noise)/Noise = 10 dB | 10 | 15 | 30 | μVrms |
| AGC Threshold | Output 3 dB below extrapolated low level gain curve value for same input | 35 | 55 | 110 | μVrms |
| AGC Figure of Merit | Number (dB) input change from 100 mVrms for 10 dB output change | 68 | 63 | 60 | dB |
| Gain Control Range | $V_1$ = 0 to $V_1$ = +5V | 80 | 70 | 66 | dB |
| Audio Output | $R_{AGC}$ = 2.4k, $V_{IN}$ 100 mVrms $f_m$ = 1 kHz, m = 0.7 | 100 | 100 | 100 | mVrms |
| | As above, $T_A$ = 100°C LM273 and LM274 only | 90 | 90 | 90 | mVrms |
| Signal to Noise Ratio | M = 0.7 to M = 0 $e_{IN}$ = 30 mVrms | 42 | 38 | 40 | dB |
| Audio Distortion | M = 0.7, $f_m$ = 1 kHz, $e_{IN}$ = 10 mV | 5 | 3.5 | 2.8 | % |
| **TYPICAL FM PERFORMANCE** (See Figures 3 and 4) | | | | | |
| Limiting Threshold | $e_O$ = 3 dB from value at $e_{IN}$ = 100 mVrms | | | | |
| | Δf = ±75 kHz | | 800 | – | μVrms |
| | Δf = ±5 kHz | 800 | 800 | – | μVrms |
| AM Rejection Ratio | $M_{fm}$ = 1, $M_{am}$ = 0.3 $e_{IN}$ = 10 mVrms | | | | |
| | Δf = ±75 kHz | | 45 | – | dB |
| | Δf = ±5 kHz | 35 | | – | dB |
| Audio Output | $e_{IN}$ = 10 mVrms | | | | |
| | Δf = ±75 kHz | | 80 | – | mVrms |
| | Δf = ±5 kHz | 70 | 38 | – | mVrms |
| | @ $T_A$ = 100°C, Δf = ±75 kHz | | 50 | – | mVrms |
| | @ $T_A$ = 100°C, Δf = ±5 kHz LM273 and LM274 only | 40 | 19 | – | mVrms |
| Audio Distortion | $e_{IN}$ = 10 mVrms | | | | |
| | Δf = ±75 kHz | | 1.5 | – | % |
| | Δf = ±5 kHz | 2 | 1.0 | – | % |
| **TYPICAL SSB PERFORMANCE** (See Figures 5 and 6) | | | | | |
| Sensitivity | (Signal + Noise)/Noise = 10 dB $e_{LO}$ = 60 mVrms | 25 | 30 | 60 | μVrms |
| AGC Threshold | Same as AM | 300 | 300 | 500 | μVrms |
| AGC Figure of Merit | Same as for AM | 60 | 60 | 50 | dB |
| Audio Output Voltage | $e_{IN}$ = 100 mVrms | 60 | 80 | 85 | mVrms |
| | $T_A$ = 100°C LM273 and LM274 only | 40 | 55 | 60 | mVrms |



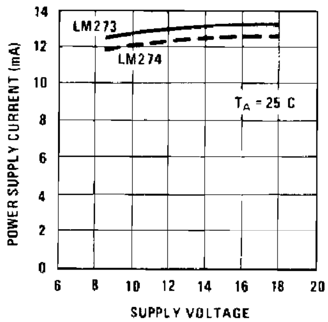
## schematic diagram



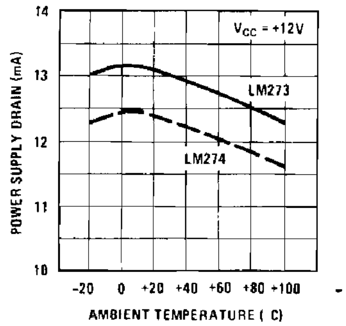
Pin connections shown are for TO-5 package only.

## typical performance characteristics

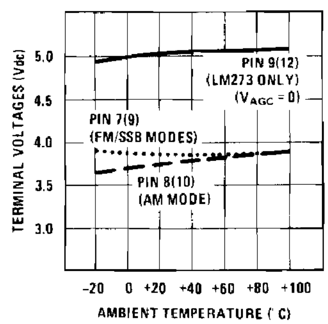
**Power Supply Current vs Supply Voltage**



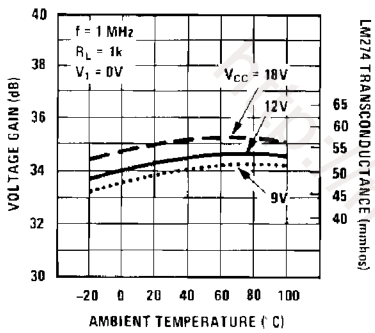

**Power Supply Current vs Ambient Temperature**



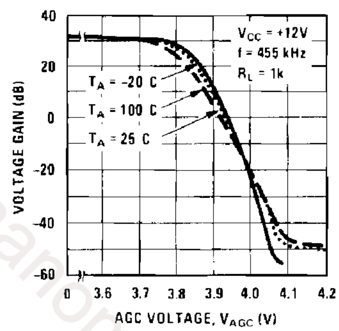

**Output Terminal Voltage vs Temperature**



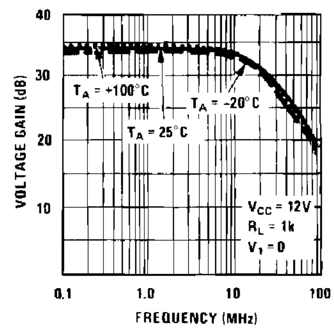

**First Section Voltage Gain or Transconductance vs Temperature**



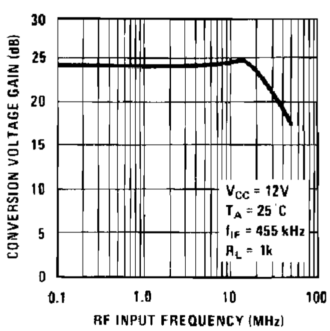

**First Section Voltage Gain vs AGC Voltage**



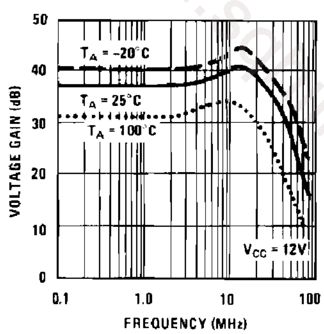

**First Section Voltage Gain vs Frequency**



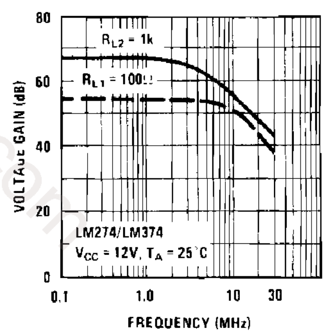

**First Section Conversion Voltage Gain vs Frequency**



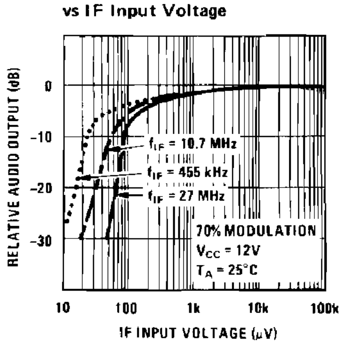

**Second Section Voltage Gain vs Frequency**



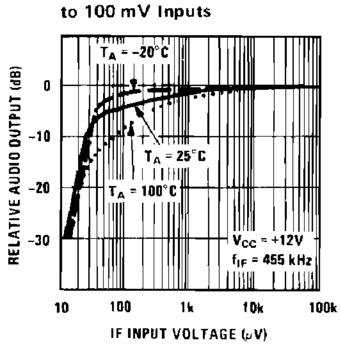

**Cascaded Sections Video Gain vs Frequency, LM274/LM374 Only**



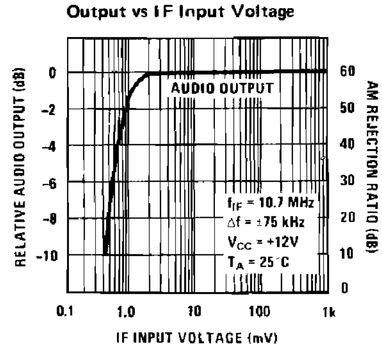

**AM IF Audio Output vs IF Input Voltage**




**Relative AM Audio Output vs IF Input Voltage, Referred to 100 mV Inputs**

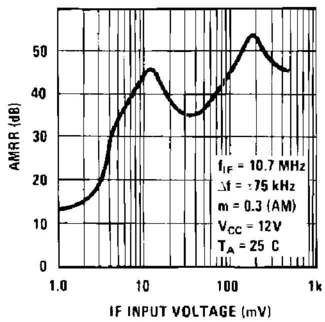



**Wide Band FM Audio Output vs IF Input Voltage**

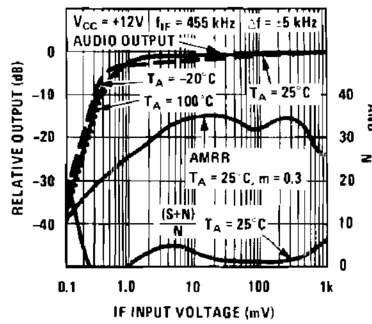


## typical performance characteristics (con't)

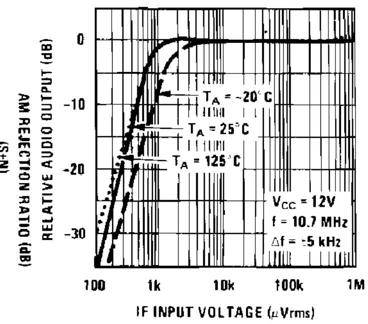
AM Rejection Ratio vs IF Input Voltage for Wide Band FM



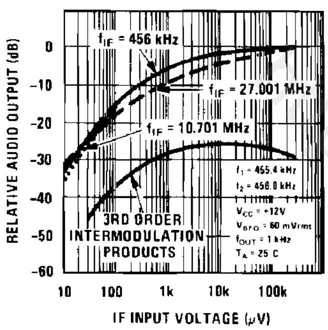

455 kHz NFM IF Audio Output, AM Rejection Ratio, and Signal to Noise vs IF Input Voltage



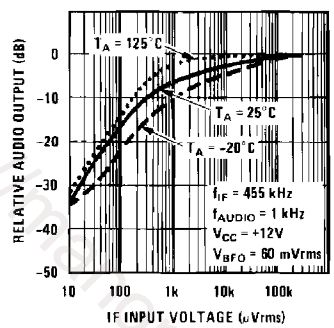

10.7 MHz NFM IF Audio Output vs IF Input Voltage



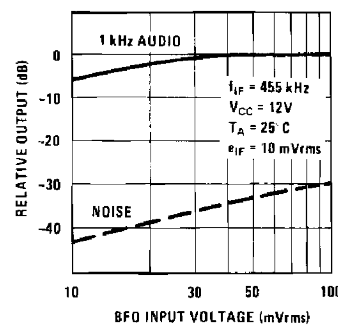

SSB IF Audio Output and Intermodulation Products vs IF Input Level




SSB IF Audio Output vs IF Input Voltage




SSB IF Audio Output vs BFO Voltage




### APPLICATION HINTS

The LM273/LM373 and LM274/LM374 devices have been designed for stability and minimum usage of external components, while at the same time offering wide versatility through access to inputs and outputs of nearly every major functional block of the device. This makes possible the detection of AM, FM, and SSB signals with a single device with a minimum of circuitry switching. Experience has shown that for optimum performance of the multiple mode IF strip, the following suggestions should be noted.

First, as with any radio frequency gain device, proper layout and minimum lead length should be observed. The first gain block, Pin 2 to Pin 9, shows a typical gain of 32 dB and the second gain block, Pin 4 to Pin 7, shows a typical gain of 37 dB so it is clear why any stray coupling or long leads should be kept clear from any of the gain input pins. Despite it's high gain, however, the device does not require any shielding between stages. Construction on a copperclad printed circuit type board is more than adequate. It should also be observed that good power supply bypassing directly at Pin 10 and DC feedback bypassing at Pin 3 is always necessary.

The devices can be wide-band coupled to provide video gain response up to approximately 50 MHz. For AM operation, however, it is much more desirable to limit the IF bandwidths. This will greatly increase both input sensitivity and AGC figure of merit by preventing the device from AGCing on wideband detected noise. There are two ways of accomplishing this. One is to insert filtering from the first gain block to the second, Pin 9 to Pin 4, but the most effective way is to AC couple an L-C tank from the input of the active peak detector to ground. A lossy filter from Pin 9 to Pin 4 should be avoided as this will greatly reduce the audio output and AGC figure merit. In addition the tank on Pin 7 should have high enough Q to limit noise yet low enough to pass the full IF signal. It should also have a high enough impedance (>5k) to avoid affecting the gain of that stage. Proper audio output is attained by a small capacitor at Pin 8 to peak detect the RF envelope, followed by a series RC roll off to shape the audio response. Here again excessive loading will reduce available output. There is a trade off available between audio level out and AGC range so the feedback resistor from Pin 8 to the AGC feedback, Pin 1, should be adjusted to give the desired results. Pin 1 must

5

be filtered well with approximately 15 μF capacitor or larger to prevent any AC variation from causing erratic AGC action.

For proper FM operation, the input level needs to be larger, on the order of 1 mV to give full limiting which is necessary for good AM rejection. Here again low loss coupling from Pin 9 to Pin 4 is desired. The phase shift network on Pin 6 should be shielded to prevent any extraneous RF pickup or radiation. Also the Q of the network should be adjusted to give the proper bandwidth for the type of signal to be detected, whether wideband or narrowband FM. Obviously, it should be tuned to the same center frequency as the IF input and the Pin 9 to Pin 4 filtering so that detection takes place symmetrically around the resonant frequency of the tank. Since the audio output for FM is at Pin 7, it should be RF bypassed along with audio rolloff and de-emphasis.

For SSB operation, the devices operate almost the same as in the AM mode, with the exception that the product detector which was unbalanced and used as a simple gain stage for AM is now balanced and used for detection. The local oscillator signal is fed into Pin 6 at an optimum level around 60 mVrms. For better AGC, a capacitor may be added to Pin 8 in addition to the one already at Pin 1 to provide even more filtering for AGC feedback voltage. The output level and AGC figure of merit is still adjusted by the feedback resistors from Pin 8 to Pin 1.

## typical applications

*Capacitors noted by asterisk are 0.1 at 455 kHz. L is Miller No. 43A105CBI for 455 kHz. 8 turns No. 26 AWG on Micrometals T25-2 Carbonyle Core (.255 OD x .100 ID x .000W) for 10.7 MHz, 3-1/2 turns No. 20 AWG 5/16" dia x 1/4" long for 27 MHz.

| f | C1 | C2 | C3 | C4 | L |
|---|---|---|---|---|---|
| 455 kHz | .01 | 1000 | .012 | .001 | 10.5 μH |
| 10.7 MHz | 1000 | 250 | 1000 | 500 | 22 μH |
| 27 MHz | 1000 | 180 | 300 | 500 | 12 μH |

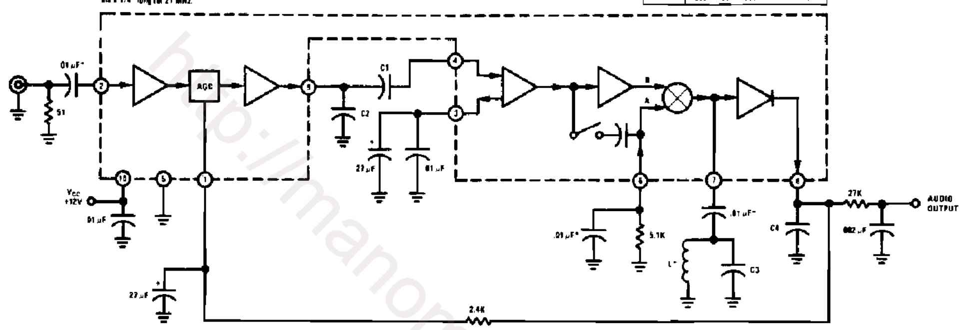
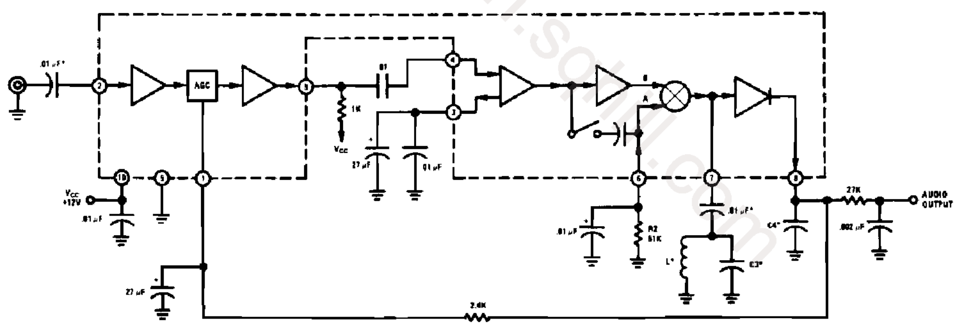


FIGURE 1. LM273/LM373 AM IF Connection



*See Figure 1 for component values.

FIGURE 2. LM274/LM374 AM IF Connection

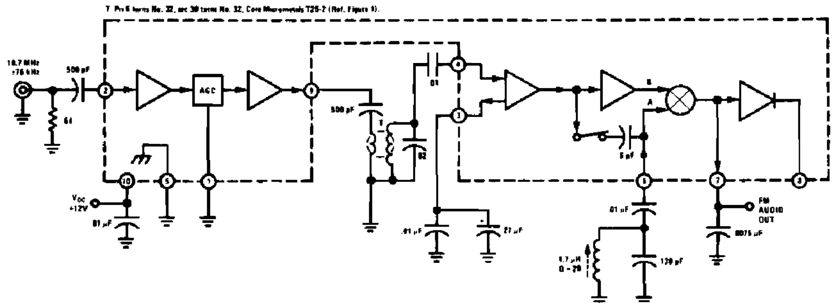


FIGURE 3. LM273/LM373 Wide Band FM IF Connection

## typical applications (con't)

*For 455 kHz, T is 8t & 60t No. 36 AWG on Micrometals T25-3 Core (Carbonyl HP, 255 OD x 120 ID x 096W), L is 680 turns universal wound No. 38 enamel with 10-32 x 1/4" Carbonyl HP core. For 10.7 MHz, T is 5t & 30t of No. 32 AWG on Micrometals T25-2 Core. L is 37t No. 36 AWG on 200 dia form with 10-32 x 1/4" Carbonyl E Core ($Q_{AV}$ = 170)

| f | C1 | R | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|---|
| 455 kHz | 500 | 0 | 1 | 05 | 5000 | 33 | 150 |
| 10.7 MHz | 01 | 300 | 01 | 500 | 43 | 47 | 82 |

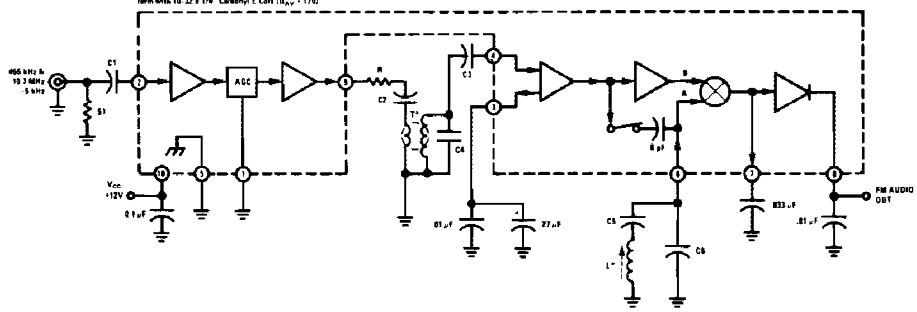
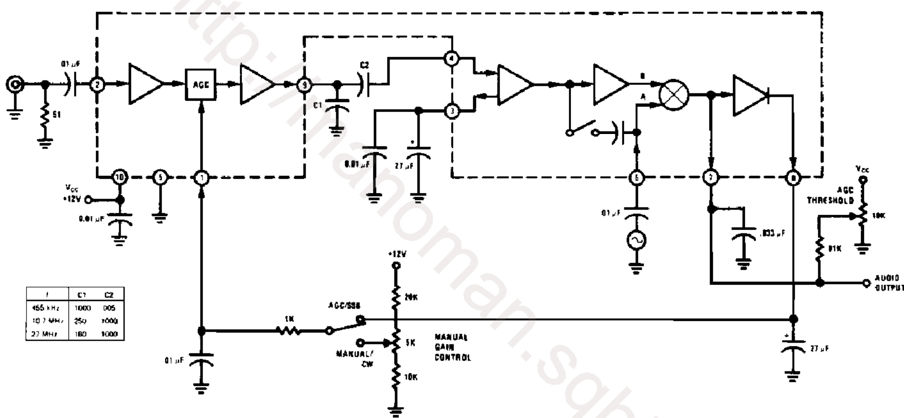



FIGURE 4. LM273/LM373 Narrow Band FM IF Connection




| f | C1 | C2 |
|---|---|---|
| 455 kHz | 1000 | 005 |
| 10.7 MHz | 250 | 1000 |
| 27 MHz | 180 | 1000 |

FIGURE 5. LM273/LM373 SSB & CW IF Connection

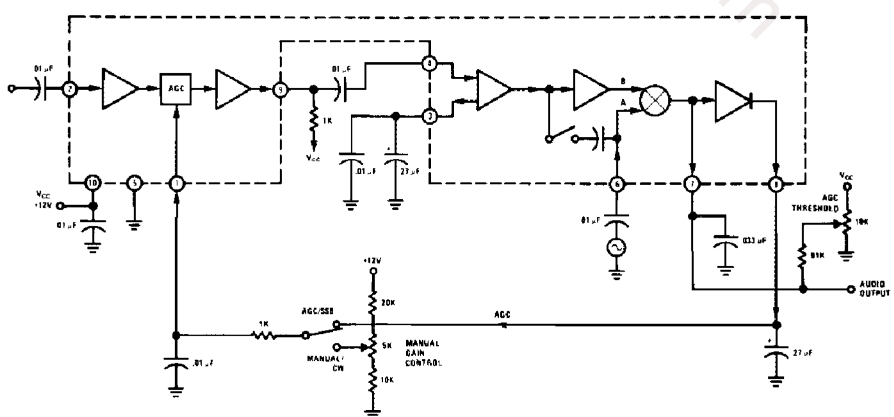



FIGURE 6. LM274/LM374 SSB & CW IF Connection

## typical applications (con't)

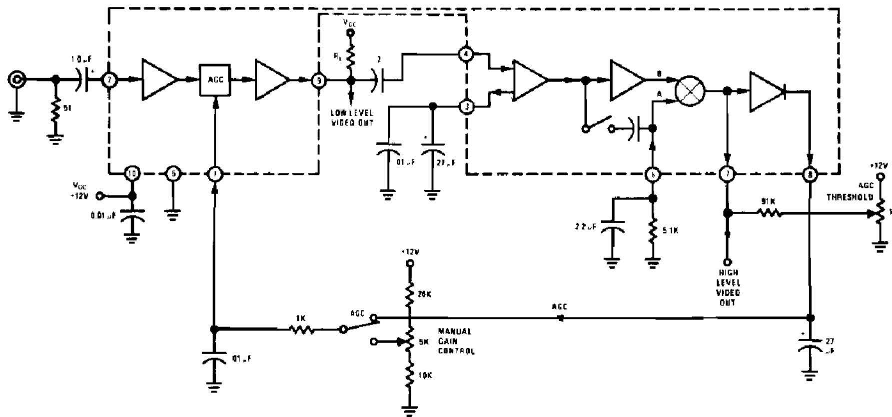



**FIGURE 7. LM274/LM374 Video Amplifier Configuration**

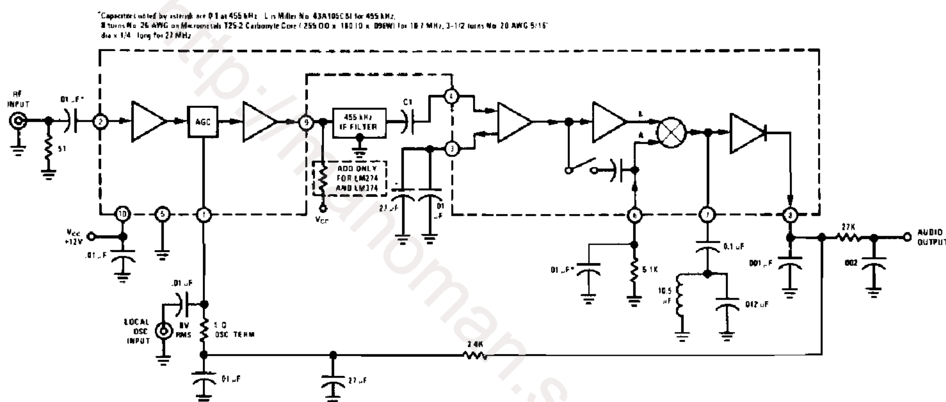



**FIGURE 8. LM274/LM374, LM273/LM373 First Stage Converter Operation for AM Signal Detection @ 455 kHz**