National Semiconductor

May 1989

LM1863 AM Radio System for Electronically Tuned Radios

General Description

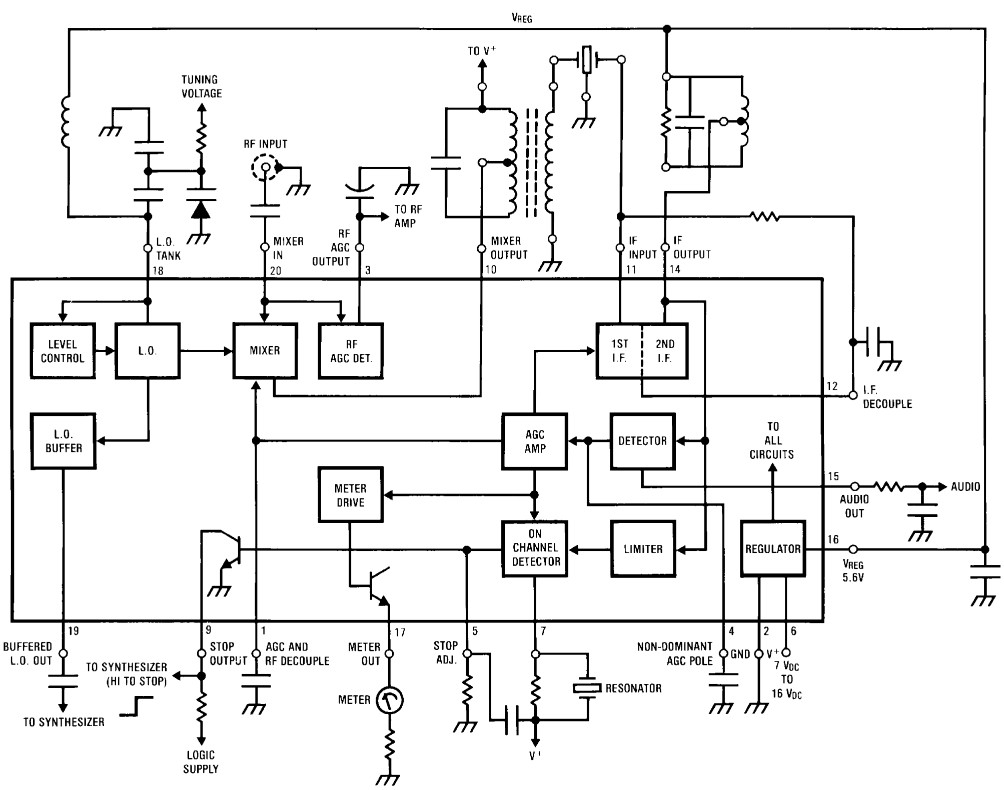
The LM1863 is a high performance AM radio system intended primarily for electronically tuned radios. Important to this application is an on-chip stop detector circuit which allows for a user adjustable signal level threshold and center frequency stop window. The IC uses a low phase noise, level-controlled local oscillator.

Low phase noise is important for AM stereo which detects phase noise as noise in the L-R channel. A buffered output for the local oscillator allows the IC to directly drive a phase locked loop synthesizer. The IC uses a RF AGC detector to gain reduce an external RF stage thereby preventing overload by strong signals. An improved noise floor and lower THD are achieved through gain reduction of the IF stage. Fast AGC settling time, which is important for accurate stop detection, and excellent THD performance are achieved with the use of a two pole AGC system. Low tweet radiation and sufficient gain are provided to allow the IC to also be used in conjunction with a loopstick antenna.

Features

- Low supply current
- Level-controlled, low phase noise local oscillator
- Buffered local oscillator output
- Stop circuitry with adjustable stop threshold and adjustable stop window
- Open collector stop output
- Excellent THD and stop time performance
- Large amount of recovered audio
- RF AGC with open collector output
- Meter output
- Compatible with AM stereo

Block Diagram



TL/H/5185–1

Order Number LM1863M
See NS Package Number M20B

 RRD-B30M115/Printed in U. S. A.

Absolute Maximum Ratings

Supply Voltage	16V
Package Dissipation (Note 1)	1.7W
Storage Temperature Range	−55°C to +150°C
Operating Temperature Range	0°C to +70°C
Soldering Information	
Small Outline Package	
Vapor Phase (60 sec)	215°C
Infrared (15 sec)	220°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

Electrical Characteristics

(Test Circuit, T_A = 25°C, V+ = 12V, SW1 = Position 1, SW2 = Position 2, unless indicated otherwise)

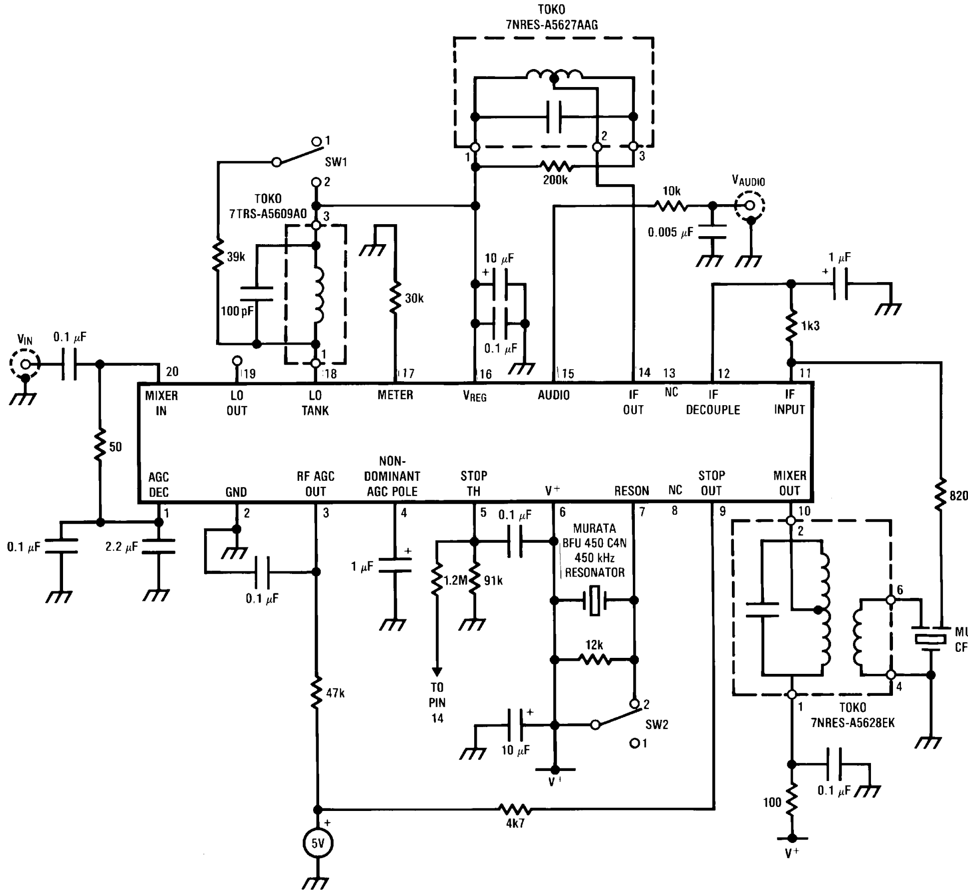
Parameter	Conditions	Min	Typ	Max	Units
STATIC CHARACTERISTICS					
Supply Current	V_{IN} = 0 mV		8.3	12.5	mA
Pin 16, Regulator Voltage			5.6		V
Operating Voltage Range	(See Note 2)	7		16	V
Pin 3 Leakage Current	V_{IN} = 0 mV		0.1		μA
Pin 9, Low Output Voltage	V_{IN} = 0 mV, SW2 = Position 1		.15		V
Pin 17, Output Voltage	V_{IN} = 0 mV		0		V
DYNAMIC CHARACTERISTICS: (f_{MOD} = 1 kHz, f_{IN} = 1 MHz, M = 0.3)					
Maximum Sensitivity	V_{IN} For V_{AUDIO} = 6 mVrms		7.5		μV
20 dB Quieting Sensitivity	V_{IN} for 20 dB S/N in Audio		15	30	μV
Maximum Signal to Noise Ratio	V_{IN} = 10 mV	40	54		dB
Total Harmonic Distortion	V_{IN} = 10 mV		.26		%
Total Harmonic Distortion	V_{IN} = 10 mV, M = 0.8		.63	2	%
Audio Output Level	V_{IN} = 10 mV	80	120	160	mVrms
Overload Distortion	V_{IN} = 50 mV, M = 0.8		7.5		%
Meter Output Voltage	V_{IN} = 100 μV		0.5		V
Meter Output Voltage	V_{IN} = 10 mV		4.6		V
Local Oscillator Output Level on Pin 19	(See Note 3), SW1 = Position 1	100	147		mVrms
Local Oscillator Output Level on Pin 19	(See Note 3), SW1 = Position 2		125		mVrms
Stop Detector Valid Station Frequency Window	V_{IN} = 10 mV, difference between the two frequencies at which Pin 9 < 1V, SW2 = Position 1	2.5	4	5.5	kHz
Stop Detector Valid Station Signal Level Threshold	Find V_{IN} for which Pin 9 > 1V, SW2 = Position 1	8	16	70	μVrms
RF AGC Threshold	Find V_{IN} that produces 10 μA of current into Pin 3	3	6	10	mVrms
Pin 3 Low Output Level	V_{IN} = 30 mV		0.1		V
Pin 9 Leakage Current	V_{IN} = 30 mV		0.1		μA
Pin 17 Output Resistance	V_{IN} = 10 mV		825		Ω

Note 1: Above T_A = 25°C derate based on $T_{j\,(MAX)}$ = 150°C and θ_{jA} = 85°C/W.

Note 2: All data sheet specifications are for V+ = 12V and may change slightly with supply.

Note 3: The local oscillator level at Pin 19 is identical to the level at Pin 18 since Pin 19 is an emitter follower off of Pin 18.

Test Circuit



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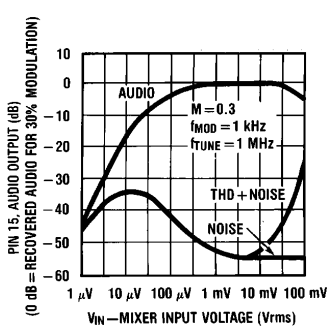
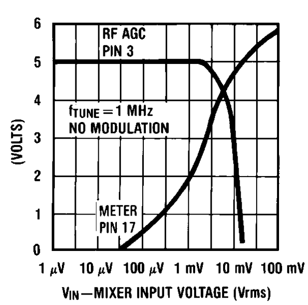
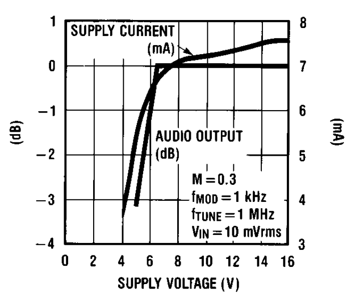
Typical Performance Characteristics (From Test Circuit)





TL/H/5185–9



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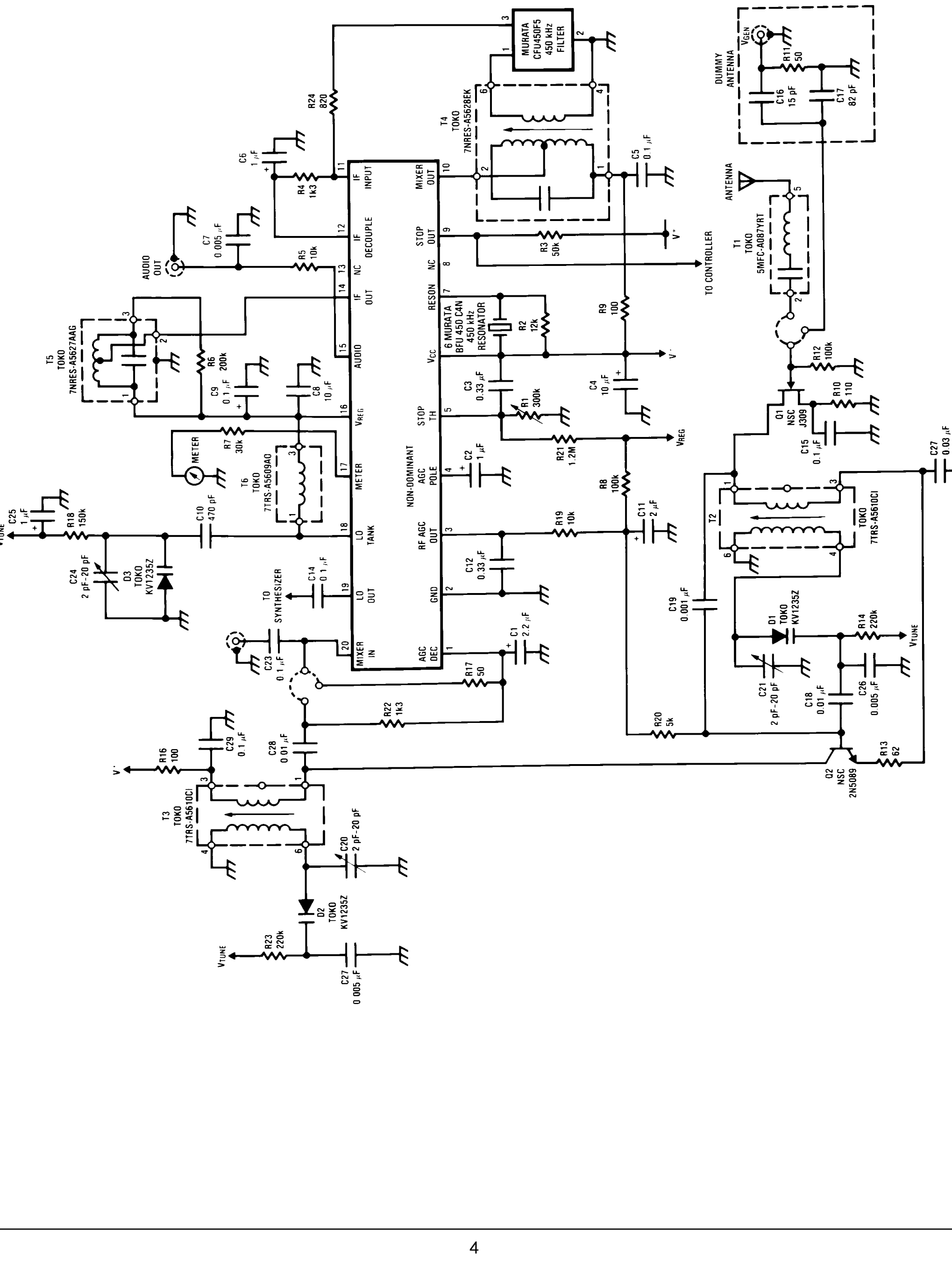
Application Circuit



LM1863: AM ETR Radio

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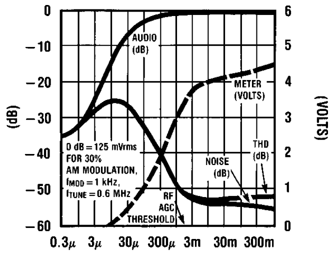
Performance Characteristics of Applications Circuit



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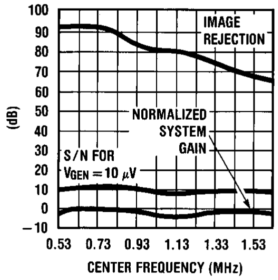

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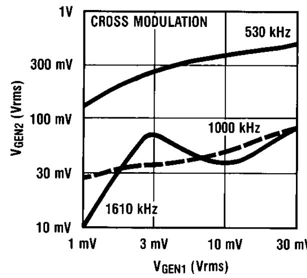

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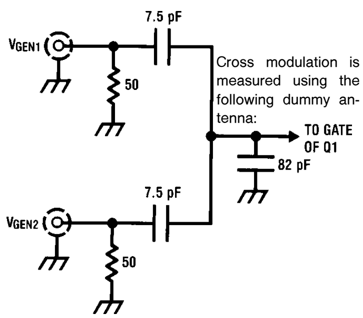

Cross modulation is measured using the following dummy antenna:

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The following procedure was used to measure cross modulation:

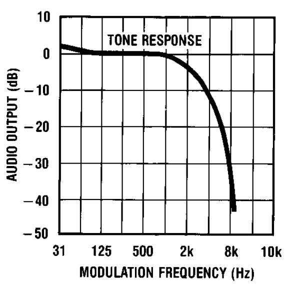
1. Tune the radio to the center frequency of interest and tune V_{GEN}, to this same frequency.

2. Set at 0 dB audio reference with V_{GEN}, = 10 mV RMS and 30% AM mod; f_{MOD} = 1 kHz.

3. Remove the modulation from V_{GEN1} and set the level of V_{GEN1}.

4. Set the modulation level of V_{GEN2} = 80% at f_{MOD} = 1 kHz and tune V_{GEN2} ± 40 kHz away from center frequency.

5. Increase the level of V_{GEN2} until −40 dB of audio is recovered. The level of V_{GEN2} is the cross modulation measurement.



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Additional Performance Information:

* THD for 80% modulation for f_{MOD} = 1 kHZ at:
  - V_{GEN} = 1V is 0.5%
  - V_{GEN} = 10 mV is 0.4%
* Tweet < 2% at all input levels.
* Typical time for valid stop indication < 50 ms.

Note: Tweet is an audio tone produced by the 2nd and 3rd harmonic of the IF beating against the received signal. It is measured as an equivalent modulation level: ie, 30% tweet has the same amplitude at the detector as a desired signal with 30% modulation.

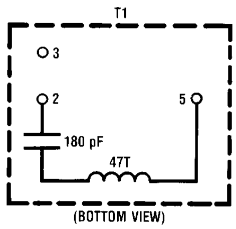
IC External Components (See Application Circuit)

Component	Typical Value	Comments
C1	2.2 μF	Sets dominant AGC pole, affects stop time and THD.
C2	1 μF	Sets non-dominant AGC pole, affects stop time and THD.
C3	0.33 μF	Stop level threshold decoupling, affects stop time and sensitivity of stop detector to large modulation peaks.
C4	10 μF	Supply decoupling, low frequency.
C5	0.1 μF	Supply decoupling, high frequency.
C6	1 μF	IF decouple, affects IF gain.
C7	0.005 μF	Audio output filter, removes IF ripple from detector.
C8	10 μF	Regulator decouple, low frequency.
C9	0.1 μF	Regulator decouple, high frequency.
C10	470 pF	Pad capacitor for varactor, affects tracking.
C11	2 μF	RF AGC decouple, affects stop time and THD.
C12	0.33 μF	RF AGC high frequency decouple.
C14	0.1 μF	Local oscillator output coupling.
C19	0.001 μF	Sets gain at high end of AM band.
C26	0.005 μF	Sets gain at low end of AM band.
C28	0.01 μF	Couples RF stage output to mixer input, keep small to insure proper stop time performance when RF AGC is active.
R1	300k Pot.	Sets level stop threshold.
R2	12k	Sets size of stop window.
R3	50k	Open collector pull up resistor.
R4	1k3	IF filter termination, and gain set.
R5	10k	Sets RC time constant on audio outputs, smaller values may cause distortion of high frequencies.
R6	200k	Sets gain of IF stage, affects noise floor and sensitivity.
R7	Meter Dependent	Sets full-scale deflection of meter.
R8	100k	Sets gain and threshold of RF AGC.
R9	100Ω	Aids mixer output decoupling.
R19	10k	Sets 2'nd pole in RF AGC, affects THD for large input signals.
R21	1.2 MΩ	Biases pin 5 to 0.4 volts which permits shorter stop time.
R24	820Ω	Sets system gain.
D1, D2, D3,	TOKO KV1235Z or Equivalent	Varactor diodes.
Resonator	450 kHz ± 1 kHz Murata*, BFU450C4N	Parallel type resonator.
IF filter	Murata* CFU450F5	Sets selectivity and tone response.

*Murata
2200 Lake Park Drive
Smyrna, GA 30080
(404) 436-1300

Performance Characteristics of Applications Circuit (Continued)

Part No. 5MFC–A087YRT
TOKO

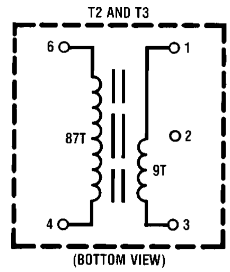


TL/H/5185–17

Center Frequency = 2 MHz

Qu > 50 at 2 MHz

Part No. 7TRS–A5610CI
TOKO

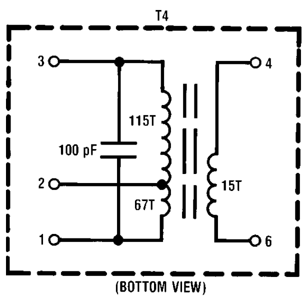


TL/H/5185–18

Qu > 95 at 1 MHz

L_{4-6} = 200 μH

Part No. 7NRES–A5628EK
TOKO

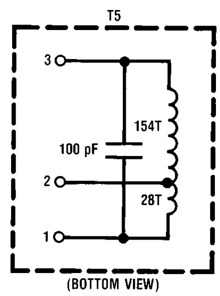


TL/H/5185–19

Center Frequency = 450 kHz

Qu > 100 at 450 kHz

Part No. 7NRES–A5627AAG
TOKO

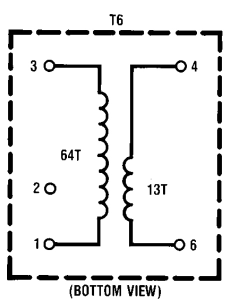


TL/H/5185–20

Center Frequency = 450 kHz

Qu > 100 at 450 kHz

Part No. 7TRS–A5609A0
TOKO



TL/H/5185–21

Center Frequency = 1 MHz

Qu > 95 at 1 MHz

L_{1-3} = 110 μH

*Toko America
1250 Feehanville Drive
Mount Prospect, IL 60056
(312) 297-0070

Layout Considerations

Although the pinout of the LM1863 has been chosen to minimize layout problems, some care is required to insure proper performance. If the LM1863 is used with a loopstick antenna, care in the placement of C3 must be observed in order to minimize tweet radiation. Orient C3 parallel to the axis of the loopstick and as far away as possible. Keep C3 close to the IC. The ground on C6 should be located near the ground terminal of the 450 kHz ceramic filter. C11 should be located near Q2 and C12 should be located near the IC. Also, the resonator on Pin 7 and resistor R2 should be located near the IC in order to minimize tweet radiation.

The mixer output, Pin 10 and the IF input, Pin 11, traces should be as short as possible to prevent stray pick up from the resonator.

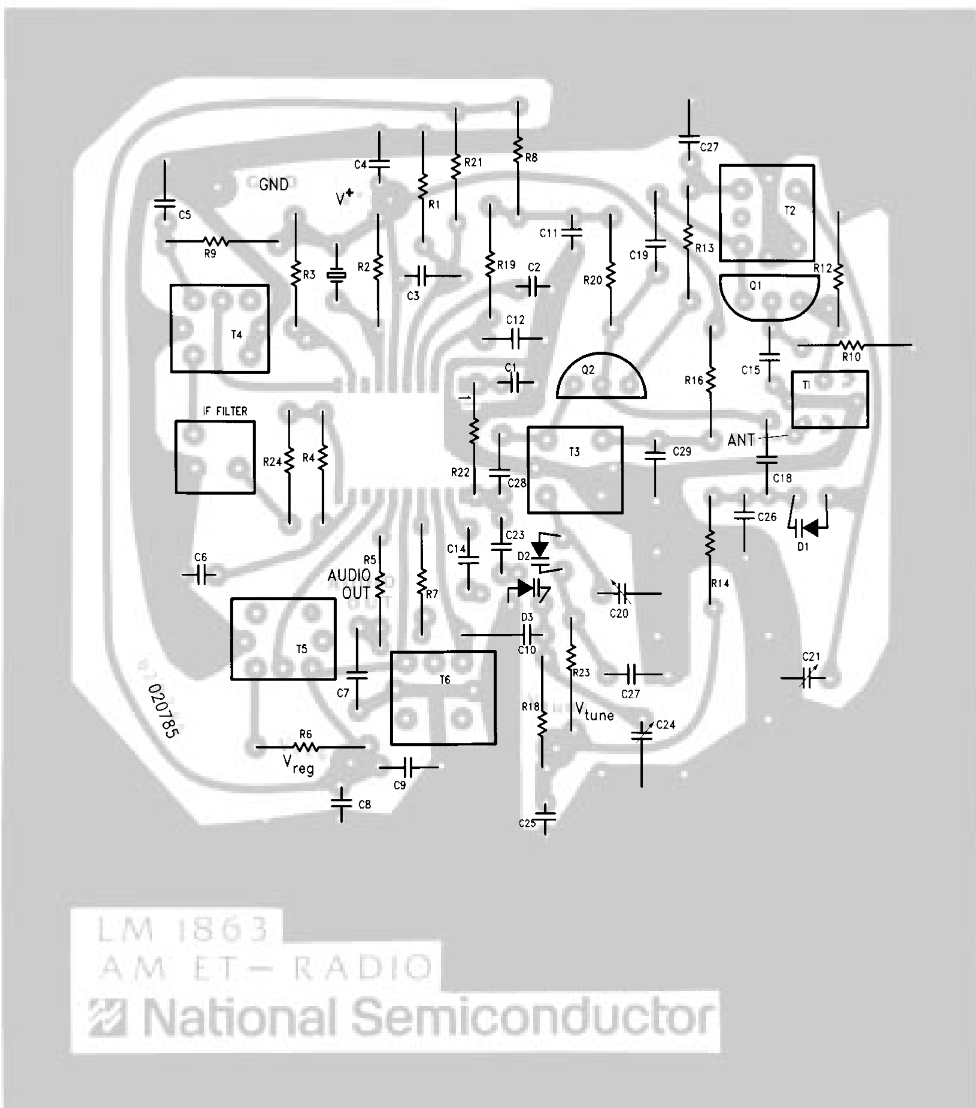
Applications Information

(See typical application and LM1863 schematic diagram.)

STOP DETECTOR

There are two criteria that determine when an electronically tuned radio is tuned to a valid station. The first criterion is that the incoming signal be of sufficient strength to be listenable. The second criterion requires that the radio be tuned

PC Layout (Component Side)



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to the center frequency of the incoming station. Both the signal strength threshold and the center tune window are externally adjustable.

The signal strength threshold is set by resistor R1. Increasing the value of this resistor will reduce the signal level threshold. There is no difficulty in setting the signal strength threshold, either above or below the AGC threshold.

Resistor R2 sets the center tune window. The incoming station is considered to be center tuned whenever the frequency of the signal at the IF output falls within the center tune window. Increasing the value of R2 will narrow the window, while decreasing R2 will widen the window. Since there is some interaction between R2 and R1, R2 should be chosen before R1. In the United States, stations within the AM band are spaced no closer than 10 kHz apart. Consequently, the controller should be set up to stop every 10 kHz within the AM band when the ETR is in scan mode. A center tune window anywhere less than ±10 kHz is therefore adequate in determining the center tune condition, though a narrower stop window is desirable in order to minimize the chance that side bands from a strong adjacent channel will fall within the stop window.

Because of asymmetry in the resonator amplitude characteristic, the center tune stop window will not be symmetric about the center frequency of the resonator. This is not a problem as long as the stop window brackets the center frequency of the IF and does not extend into the next channel. However, in order to avoid any problems in this regard it is recommended that the resonator center frequency deviate no more than ±1 kHz from the center frequency of the IF.

The stop output, Pin 9, is an open collector NPN transistor. This output must be taken to a positive voltage through a load resistor, R3. A valid stop condition is indicated by a high output level on Pin 9 (i.e., the NPN is turned off). The voltage on this pin should not exceed 16 volts.

STOP DETECTOR STOP TIME

The amount of time required for the LM1863 to output an accurate stop indication on Pin 9 is defined as the stop time. The stop time determines how quickly the ETR can scan across the AM band. There are several factors that influence the stop time. Since the signal level stop function operates in conjunction with the Automatic Gain Control (AGC), the AGC settling time is a critical factor. This settling time is dominated by the low frequency AGC pole which is set by C1 and internal IC resistances. Decreasing C1 will decrease the AGC settling time but increase total harmonic distortion, THD, of the recovered audio. A good compromise between AGC settling time and THD is very difficult to reach with a single pole AGC system. Consequently, the LM1863 has been designed with a second, higher frequency, AGC pole. This non-dominant pole is externally set by capacitor C2. As a result, C1 can be made much smaller than it otherwise could for an equivalent amount of THD. Reducing C1 will reduce the stop time. The combination of C1 and C2 as shown in the applications circuit results in a stop time of less than 50 ms for most input conditions, while at the same time the circuit achieves .9% THD at 80% modulation with 400 Hz modulation frequency at 10 mV input signal strength. Had C2 not been present the stop time would still be 50 ms but the THD for similar input conditions would be 8%. By decreasing both C1 and C2 (keeping the ratio of C1/C2 constant) the stop time can be reduced at the expense of THD, while the converse is also true.

The addition of a second pole to the AGC response does add some ringing to the AGC voltage following signal transients. The frequency, duration and amount of ringing are dependent on where both AGC poles are placed and to some extent the input signal conditions. The amount of ringing should be kept to a minimum in order to insure proper stop indications. The amount of ringing can be reduced by either reducing C2 (this will increase THD) or by increasing C1 (this will improve THD but increase stop time).

If the ratio of C1/C2 is made too small, an increase in low frequency noise may be noticed resulting from the peaking that a closed loop two pole system exhibits near the unity gain frequency. The extent of this peaking can be observed by examining the amount of recovered audio at various low frequency modulations. In general, the values shown reach a good compromise between THD, stop time, ringing and low frequency noise.

The center tuning detector on the LM1863 passes the signal at the IF output through a limiting amplifier which removes most of the modulation from the IF waveform. The output of this limiter is then applied to the resonator on Pin 7. Unfortunately, large modulation peaks are not completely removed by the limiting amplifier. Without C3, these large modulation peaks would cause glitches on the stop output when the LM1863 was tuned to a valid station. C3 acts to reduce these glitches by filtering the output of the center tune circuit. C3, however, also affects the stop time and cannot be made arbitrarily large. A time constant of about 30 ms on Pin 5 gives the best compromise. R21 biases Pin 5 to about .4 volts, which is below the stop threshold at this point. This biasing results in a shorter stop time.

Extra precaution can be taken within the software of the controller IC to further insure accurate stop detector performance over a wide variety of input signal conditions. A typical controller IC stop algorithm is as follows:

> The controller waits the first 10 ms after the LM1863 is tuned to the next channel. The controller then samples the LM1863 stop output 10 times within the next 40 ms. If no high output is sensed within that time the controller concludes there is no valid station at the frequency and moves to the next channel. If, however, at least one high output is detected within the first 50 ms the controller waits an additional 200 ms and at the end of that time re-samples the stop output in order to make its final stop determination.

RF AGC

The RF AGC detector is designed to control the gain of an external RF amplifier which is placed between the antenna and the mixer input. The RF AGC operates by detecting when the input signal to the mixer reaches 6 mVrms, the RF AGC threshold. When the mixer input signal reaches this level the RF AGC is activated and will hold the mixer input level relatively constant at the level of the RF AGC threshold. The gain of the RF AGC determines how constant the RF AGC can control the RF output. The LM1863 RF AGC is high gain and consequently the RF AGC output, Pin 3, will transition from high to low over a very narrow input range to the mixer when the LM1863 is examined in an OPEN LOOP condition. However, in a radio where the RF AGC controls the RF gain, a CLOSED LOOP negative feedback system is established. In this application the RF AGC output will transition from high to low over a large range of signal levels to the input of the RF stage.

Applications Information (Continued)

The RF AGC threshold has been carefully chosen to prevent overloading the mixer, which would cause distortion and tweet problems. However, the threshold level is sufficiently large to minimize the possibility of strong adjacent stations de-sensitizing the radio by activating the RF AGC and thereby gain reducing the RF front end.

The RF AGC output, Pin 3, is an open collector NPN transistor. This collector must be tied to a positive voltage through a load resistor, R8. Furthermore, decoupling is required (C11 and C12) in order to insure that the RF AGC does not induce significant distortion in the recovered audio. However, the tradeoff between good THD performance and fast stop time is not too severe for the RF AGC because large changes in the RF AGC level are unlikely when moving between adjacent channels. This is because the selectivity in the RF stage is not great enough to cause abrupt signal level changes at the mixer input as the radio is tuned. Thus, since the RF AGC does not have to follow abrupt signal level changes, the time constant on the AGC output can be relatively long which allows for good THD performance. C12 is required in order to insure good RF decoupling of signals at the RF AGC output, and sets the non-dominant pole.

The RF AGC 10 μA threshold is fixed at 6 mVrms at the mixer input. However, due to the gain of the RF stage and losses through the RF transformers, this level may be different when referenced to the antenna input. For the application circuit shown the RF threshold occurs at 2 mVrms at the dummy antenna input. Thus, the RF AGC threshold can effectively be adjusted by altering the gain of the RF stage. The value of R8 also has some affect on the RF AGC threshold of the application circuit. Smaller values will tend to increase the threshold while larger values will tend to reduce the threshold.

GAIN DISTRIBUTION

The purpose of this section is to clarify some of the tradeoffs involved in redistributing gain from one portion of the radio to another. An AM radio basically has three gain blocks consisting of the RF stage, the mixer, and the IF stage. The total gain of these three blocks must be sufficiently large as to insure reception of weak stations. Given then a fixed amount of required gain how does distributing this gain among the three blocks affect the radio performance?

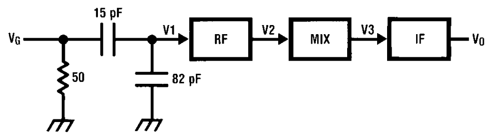
Large amounts of gain in the RF stage will have the effect of decreasing the RF AGC threshold. A decreased RF AGC threshold means that it is more likely that strong adjacent stations can activate the RF AGC and desensitize the radio. Also, a lot of RF gain implies large signals across the RF varactor diodes, which is undesirable for good tracking and can result in overloading these varactors which can cause cross modulation. On the other hand, high RF gain insures good noise performance and improved THD.

High mixer gain implies large signal swings at the mixer output, especially on AGC transients. These large signal swings could cause the mixer ouput transistors to saturate and also could overload the IF stage. On the other hand, redistributing the gain from the IF to the mixer would improve the noise performance of the radio. The gain of the mixer can be controlled moving the tap on the mixer output transformer, T4.

Since the output signal level of the IF is held constant by the AGC, increasing gain in the IF has the effect of reducing the signal level at the IF input. Noise sources at the IF input therefore become a larger percentage of the IF input signal thereby degrading the S/N floor of the radio. For this reason, the LM1863 employs 20 dB of IF AGC. The IF gain of the LM1863 is adjustable by changing the tap across the IF ouput coil, or by changing the ratio of R24 to R4.

The gain distribution for the application circuit is as follows:

Gain Distribution



TL/H/5185–23

V_G	= 0 dB	(10 μV)
V1	= −16 dB	
V2	= +10 dB	(Pin 20)
V3	= +33 dB	(Pin 11)
V_O	= +84 dB	(Pin 14)

The IF gain could also be varied by changing the value of R6 across the IF output coil. However, it is a good idea to maintain a high Q IF tank in order to achieve good adjacent channel rejection. In order to prevent distortion due to overloading the IF amplifier, it is important that the impedance Pin 14 sees looking into the IF output tank, T5, does not go below 3K ohms.

The above gain distribution is prior to any AGC action in the radio. This distribution represents a good compromise between the various tradeoffs outlined previously.

LEVEL CONTROLLED LOCAL OSCILLATOR

Tracking of the RF varactors with the local oscillator varactor is a serious consideration in order to insure adequate performance of the ETR radio. Due to non-linear capacitance versus voltage characteristic of the varactor, large signals across these varactors will tend to modulate their capacitance and cause tracking problems. This problem is compounded further if the level of the signals across the varactors change. In an AM radio, the local oscillator frequency changes a ratio of two to one. The Q of the oscillator tank remains fairly constant over this range. Thus, since $Q = R_P/\omega L$ = Constant, this implies that R_P(R_P = unloaded parallel resistance of the tank) must change two to one. The internal level-control loop prevents the two to one change in AC voltage across the tank which the change in the R_P would otherwise cause.

Phase jitter of the local oscillator is very important in regard to AM stereo, where L-R information is contained in the phase of the carrier. Local oscillator jitter has the effect of modulating the L-R channel with phase noise, thus degrading the stereo signal to noise performance. Great care has been taken in the design of the LM1863 local oscillator to insure that phase jitter is a minimum. In fact the dominant source of phase jitter is the high impedance resistor drive to the varactor. The thermal noise of the resistor modulates the varactor voltage, thus causing phase jitter.

VARACTOR TUNED RF STAGE

Electronically tuned car radios require the use of a tuned RF stage prior to the mixer. Many of the performance charac-

Applications Information (Continued)

teristics of the radio are determined by the design of this stage. Generally speaking it is very difficult to design an integrated RF stage in bipolar, as bipolar transistors do not have good overload characteristics. Thus, the RF stage is usually designed using discrete components. Because of this there is a great deal of concern with minimizing the number of discrete components without severely sacrificing performance. The applications circuit RF stage does just this.

The circuit consists of only two active devices, an N-channel JFET, Q1, which is connected in a cascode type of configuration with an NPN BJT, Q2. Both Q1 and Q2 are varactor tuned gain stages. Q2 also serves to gain reduce Q1 when Q2's base is pulled low by the RF AGC circuit on the LM1863. The gain reduction occurs because Q1 is driven into a low gain resistive region as its drain voltage is reduced. R10 and C15 set the gain of the 1'st RF stage which is kept high (about 19 dB) for good low signal, signal/noise performance. The gain of the front end to the mixer input referenced to the generator output is about +10 dB.

T2 in conjunction with D1, C21 and C26 form the 1'st tuned circuit. C26 does not completely de-couple the RF signal at the cathode of the varactor. In fact, the combination of C26 and C19 act to keep the gain of the whole RF stage constant over the entire AM band. Without special care in this regard the gain variation could be as high as 14 dB. This gain variation would result from the increase in impedance at the secondary's of T2 and T1 as the tuned frequency is increased. The increased impedance results from a constant Q=Rp/(wL) of the tanks over the AM band. With C26 and C19 the gain is held constant to within 6 dB (including the tracking error) over the entire AM band.

C27 de-couples RF signal from the top of T2's primary and allows Q2 to operate properly. C18 is a coupling capacitor which in conjunction with C19 couples the signal from the 1'st RF stage to the 2'nd RF stage. R20 acts to isolate this signal from AC ground at C11. R19 acts in conjunction with C12 to set a high frequency (ie: non-dominant) RF AGC pole which is important for low distortion when the RF AGC is active. The dominant RF AGC pole is set by R8 and C11. Q2 is a high beta transistor allowing for little voltage drop across R20 and R8 due to base current. This keeps the emitter of Q2 sufficiently high (in the absence of RF AGC) to bias Q1 in its square law region.

R13 acts to reduce the 2'nd stage gain and increase Q2's signal handling. R13 must not get too large, however, (ie: R13>100 Ω), or low level signal/noise will be degraded. T3 in conjunction with C20, C27 and D2 form the 2'nd RF tuned circuit. The output of Q2 is capacitively coupled through C28 to the mixer input. The output of Q2 is loaded not only by the reflected secondary impedance but also by R22. R22 is carefully chosen to load the 2'nd stage tuned circuit and broaden its bandwidth. The increased bandwidth of the 2'nd stage greatly improves the cross modulation performance of the front end. In the absence of this increased bandwidth, the relatively large AC signals across varactor D2 result in cross modulation. R22 also reduces the total gain of the 2'nd stage. R22 does slightly degrade (by about 6 dB) the image rejection especially at the high end of the AM band. However, the image rejection of this front end is still excellent and 6 dB is a small price to pay for the greatly increased immunity to cross modulation.

R16 and C29 decouple unwanted signals on V+ from being coupled into the RF stage. This front end also offers superior performance with respect to varactor overload by strong adjacent channels. This results because of the way that gain has been distributed between the 1'st and 2'nd stages.

In summary, this front end offers two stages of RF gain with the 2'nd stage acting to gain reduce the 1'st stage when RF AGC is active. Furthermore, a unique coupling scheme is employed from the output of the 1'st stage to the input of the 2'nd stage. This coupling scheme equalizes the gain from one end of the AM band to the other. Additional care has been taken to insure that excellent cross modulation performance, image rejection, signal to noise performance, overload performance, and low distortion are achieved. Performance characteristics for this front end in conjunction with the LM1863 are shown in the data sheet. Also, information with regard to the bandwidth of the front end versus tuned frequency are given below.

TUNED FREQUENCY	−3 dB BANDWIDTH
530 kHz	6.6 kHz
600 kHz	7.2 kHz
1200 kHz	20.6 kHz
1500 kHz	26.4 kHz
1630 kHz	36 kHz

VARACTOR ALIGNMENT PROCEDURE

The following is a procedure which will allow you to properly align the RF and local oscillator trim capacitors and coils to insure proper tracking across the AM band.

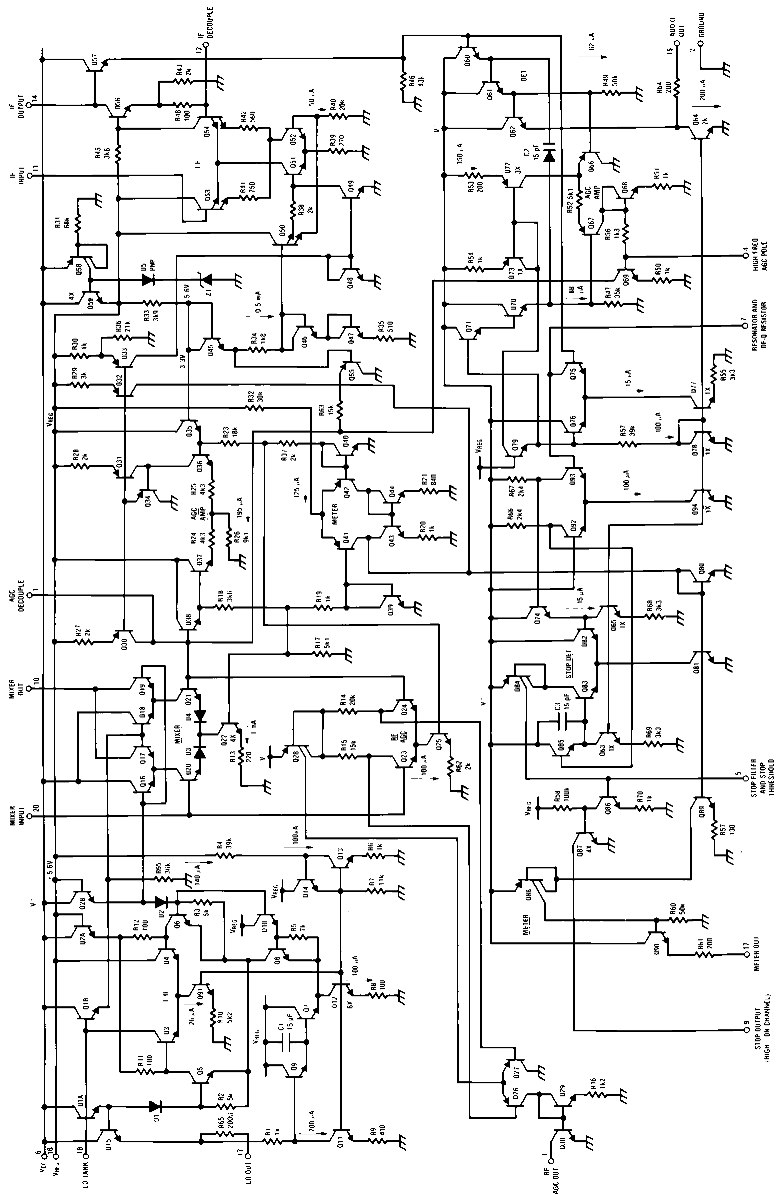
1. Set the voltage across the varactors=1 volt.
2. Set the trimmers to 50%.
3. Adjust the oscillator coil until the local oscillator is at 980 kHz.
4. Increase the varactor voltage until the local oscillator (L0) is at 2060 kHz and check to see if this voltage is less than 9.5 volts but greater than 7.5 volts. If it is then the L0 is aligned. If it is not then adjust the L0 coil/trimmer until the varactor voltage falls in this range.
5. Set the RF in to 600 kHz and adjust the tuning voltage until the L0 is at 1050 kHz. Peak all RF coils for maximum recovered audio at low input levels.
6. Set RF in to 1500 kHz and adjust the tuning voltage until the L0 is at 1950 kHz. Peak all RF trim capacitors for maximum recovered audio at low input levels.
7. Go back to step 5 and iterate for best adjustment.
8. Check the radio gain at 530 kHz and 750 kHz to make sure that the gain is about the same at these two frequencys. If it is not, then slightly adjust the RF coils until it is.

The above procedure will insure perfect tracking at 600 kHz, 950 kHz and 1500 kHz. The amount of gain variation across the AM band using the above procedure should not exceed 6 dB.

ADDITIONAL INFORMATION

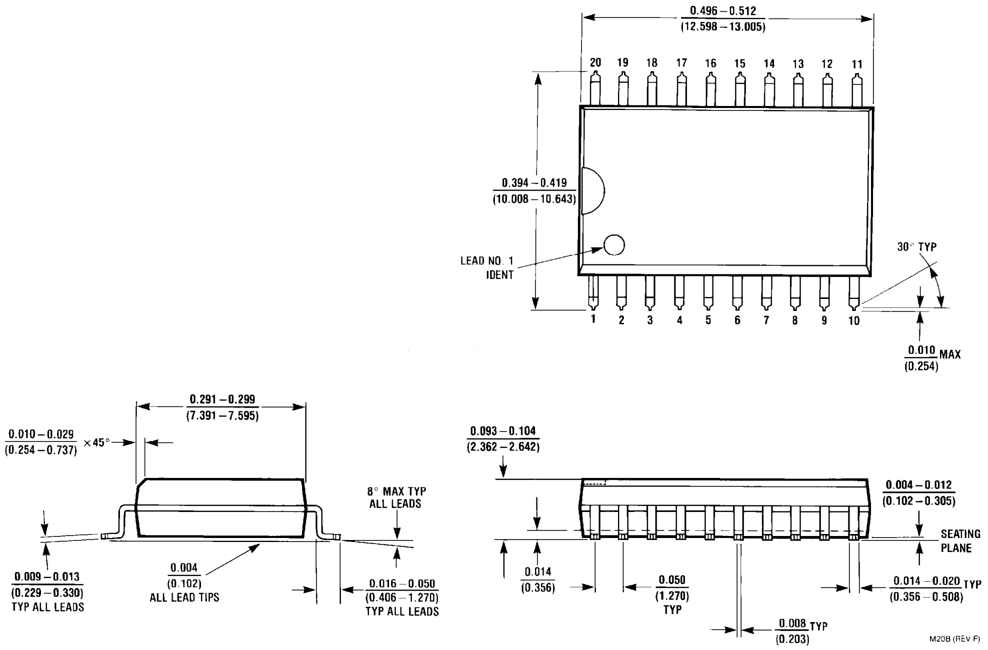
R5 and C7 act as a low pass filter to remove most of the residual 450 kHz IF signal from the audio output. Some residual 450 kHz signal is still present, however, and may need to be further removed prior to audio amplification. This need becomes more important when the LM1863 is used in conjunction with a loopstick antenna which might pick up an amplified 450 kHz signal. An additional pole can be added to the audio output after R5 and C7 prior to audio amplification if further reduction of the 450 kHz component is required.

Equivalent Schematic Diagram



TL/H/5185–24

Physical Dimensions inches (millimeters)



Plastic Small Outline Package (M)
Order Number LM1863M
NS Package Number M20B

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