

# Low Power Dual Conversion FM Receiver

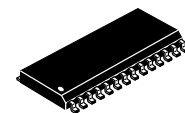
The MC3363 is a single chip narrowband VHF FM radio receiver. It is a dual conversion receiver with RF amplifier transistor, oscillators, mixers, quadrature detector, meter drive/carrier detect and mute circuitry. The MC3363 also has a buffered first local oscillator output for use with frequency synthesizers, and a data slicing comparator for FSK detection.

- Wide Input Bandwidth – 200 MHz Using Internal Local Oscillator  
– 450 MHz Using External Local Oscillator
- RF Amplifier Transistor
- Muting Operational Amplifier
- Complete Dual Conversion
- Low Voltage:  $V_{CC} = 2.0 \text{ V to } 6.0 \text{ Vdc}$
- Low Drain Current:  $I_{CC} = 3.6 \text{ mA (Typical)}$  at  $V_{CC} = 3.0 \text{ V}$ , Excluding RF Amplifier Transistor
- Excellent Sensitivity: Input  $0.3 \mu\text{V}$  (Typical) for 12 dB SINAD Using Internal RF Amplifier Transistor
- Data Shaping Comparator
- Received Signal Strength Indicator (RSSI) with 60 dB Dynamic Range
- Low Number of External Parts Required
- Manufactured in Motorola's MOSAIC® Process Technology

## MC3363

### LOW POWER DUAL CONVERSION FM RECEIVER

#### SEMICONDUCTOR TECHNICAL DATA

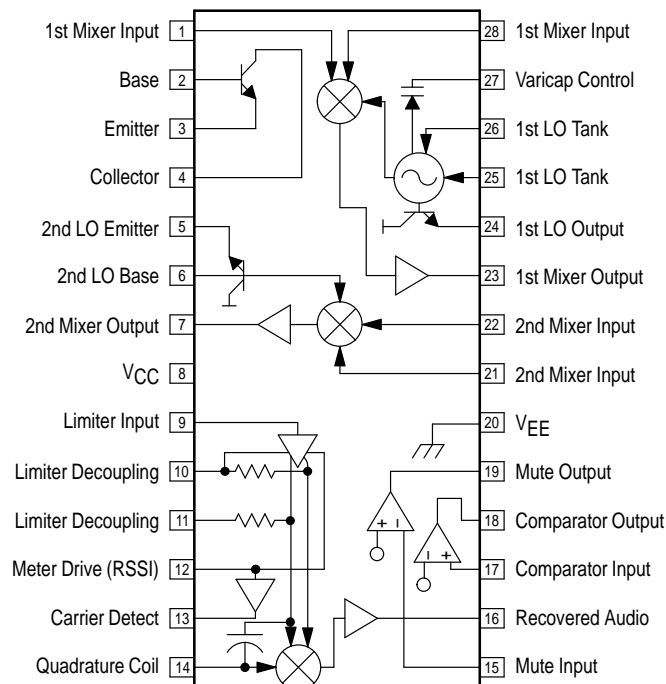


**DW SUFFIX**  
PLASTIC PACKAGE  
CASE 751F  
(SO-28L)

#### ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC3363DW	$T_A = -40 \text{ to } +85^\circ\text{C}$	SO-28L

**Figure 1. Pin Connections and Representative Block Diagram**



# MC3363

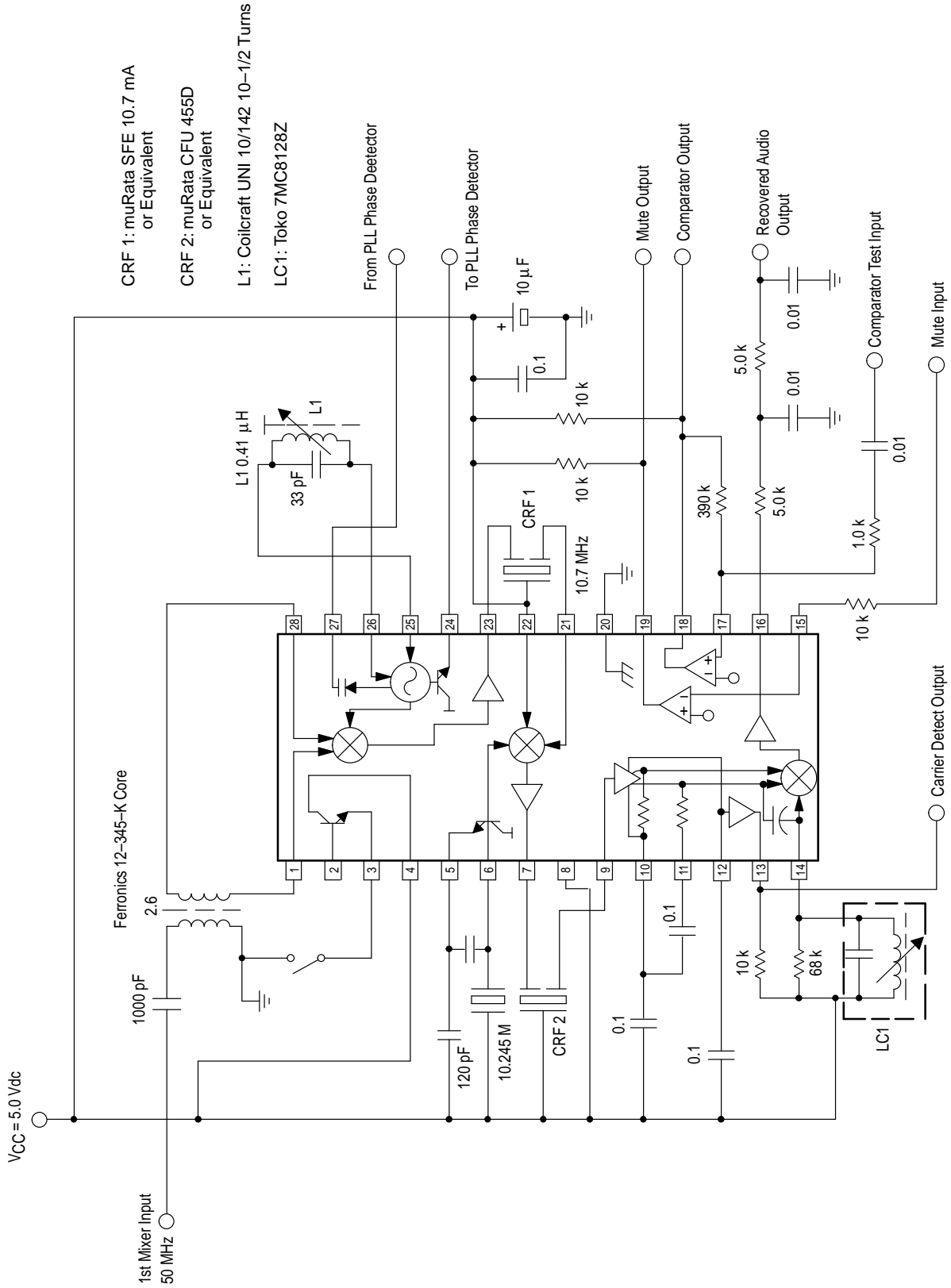
## MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

Rating	Pin	Symbol	Value	Unit
Power Supply Voltage	8	V <sub>CC(max)</sub>	7.0	Vdc
Operating Supply Voltage Range (Recommended)	8	V <sub>CC</sub>	2.0 to 6.0	Vdc
Input Voltage (V <sub>CC</sub> = 5.0 Vdc)	1, 28	V <sub>1-28</sub>	1.0	Vrms
Mute Output Voltage	19	V <sub>19</sub>	-0.7 to 8.0	Vpk
Junction Temperature	-	T <sub>J</sub>	150	°C
Operating Ambient Temperature Range	-	T <sub>A</sub>	-40 to +85	°C
Storage Temperature Range	-	T <sub>stg</sub>	-65 to +150	°C

## ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = 5.0 Vdc, f<sub>o</sub> = 49.7 MHz, Deviation = ±3.0 kHz, T<sub>A</sub> = 25°C, Mod 1.0 kHz, test circuit of Figure 2 unless otherwise noted)

Characteristic	Pin	Min	Typ	Max	Units
Drain Current (Carrier Detect Low)	8	-	4.5	8.0	mA
-3.0 dB Limiting Sensitivity (RF Amplifier Not Used)		-	0.7	2.0	μVrms
Input For 12 dB SINAD		-	0.3	-	
20 dB S/N Sensitivity (RF Amplifier Not Used)		-	1.0	-	
1st Mixer Input Resistance (Parallel - R <sub>p</sub> )	1, 28	-	690	-	Ω
1st Mixer Input Capacitance (Parallel - C <sub>p</sub> )	1, 28	-	7.2	-	pF
1st Mixer Conversion Voltage Gain (A <sub>VC1</sub> , Open Circuit)		-	18	-	dB
2nd Mixer Conversion Voltage Gain (A <sub>VC2</sub> , Open Circuit)		-	21	-	
2nd Mixer Input Sensitivity (20 dB S/N) (10.7 MHz i/p)	21	-	10	-	μVrms
Limiter Input Sensitivity (20 dB S/N) (455 kHz i/p)	9	-	100	-	
RF Transistor DC Current Drain	4	1.0	1.5	2.5	mAdc
Noise Output Level (RF Signal = 0 mV)	16	-	70	-	mVrms
Recovered Audio (RF Signal Level = 1.0 mV)	16	120	200	-	mVrms
THD of Recovered Audio (RF Signal = 1.0 mV)	16	-	2%	-	%
Detector Output Impedance	16	-	400	-	Ω
Series Equivalent Input Impedance	1	-	450-j350	-	
Data (Comparator) Output Voltage - High - Low	18	- 0.1	- 0.1	V <sub>CC</sub> -	Vdc
Data (Comparator) Threshold Voltage Difference	17	70	110	150	mV
Meter Drive Slope	12	70	100	135	nA/dB
Carrier Detect Threshold (Below V <sub>CC</sub> )	12	0.53	0.64	0.77	Vdc
Mute Output Impedance - High - Low	19	- -	10 25	- -	MΩ

Figure 2. Test Circuit



CRF 1: muRata SFE 10.7 mA  
or Equivalent

CRF 2: muRata CFJ 455D  
or Equivalent

L1: Coilcraft UNI 10/142 10-1/2 Turns

LC1: Toko 7MC8128Z

## CIRCUIT DESCRIPTION

The MC3363 is a complete FM narrowband receiver from RF amplifier to audio preamp output. The low voltage dual conversion design yields low power drain, excellent sensitivity and good image rejection in narrowband voice and data link applications.

In the typical application, the input RF signal is amplified by the RF transistor and then the first mixer amplifies the signal and converts the RF input to 10.7 MHz. This IF signal is filtered externally and fed into the second mixer, which further amplifies the signal and converts it to a 455 kHz IF signal. After external bandpass filtering, the low IF is fed into the limiting amplifier and detection circuitry. The audio is recovered using a conventional quadrature detector. Twice-IF filtering is provided internally.

The input signal level is monitored by meter drive circuitry which detects the amount of limiting in the limiting amplifier. The voltage at the meter drive pin determines the state of the carrier detect output, which is active low.

## APPLICATIONS INFORMATION

The first local oscillator is designed to serve as the VCO in a PLL frequency synthesized receiver. The MC3363 can operate together with the MC145166/7 to provide a two-chip ten-channel frequency synthesized receiver in the 46/49 cordless telephone band. The MC3363 can also be used with the MC14515X series of CMOS PLL synthesizers and MC120XX series of ECL prescalers in VHF frequency synthesized applications to 200 MHz.

For single channel applications the first local oscillator can be crystal controlled. The circuit of Figure 4 has been used successfully up to 60 MHz. For higher frequencies an external oscillator signal can be injected into Pins 25 and/or 26 — a level of approximately 100 mVrms is recommended. The first mixer's transfer characteristic is essentially flat to 450 MHz when this approach is used (keeping a constant 10.7 MHz IF frequency). The second local oscillator is a Colpitts type which is typically run at 10.245 MHz under crystal control.

The mixers are doubly balanced to reduce spurious responses. The first and second mixers have conversion gains of 18 dB and 21 dB (typical), respectively. Mixer gain is stable with respect to supply voltage. For both conversions, the mixer impedances and pin layout are designed to allow the user to employ low cost, readily available ceramic filters.

Following the first mixer, a 10.7 MHz ceramic bandpass filter is recommended. The 10.7 MHz filtered signal is then fed into the second mixer input Pin 21, the other input Pin 22 being connected to  $V_{CC}$ .

The 455 kHz IF is filtered by a ceramic narrow bandpass filter then fed into the limiter input Pin 9. The limiter has 10  $\mu$ V sensitivity for -3.0 dB limiting, flat to 1.0 MHz.

The output of the limiter is internally connected to the quadrature detector, including a quadrature capacitor. A

parallel LC tank is needed externally from Pin 14 to  $V_{CC}$ . A 68 k $\Omega$  shunt resistance is included which determines the peak separation of the quadrature detector; a smaller value will lower the Q and expand the deviation range and linearity, but decrease recovered audio and sensitivity.

A data shaping circuit is available and can be coupled to the recovered audio output of Pin 16. The circuit is a comparator which is designed to detect zero crossings of FSK modulation. Data rates of up to 35000 baud are detectable using the comparator. Best sensitivity is obtained when data rates are limited to 1200 baud maximum. Hysteresis is available by connecting a high-valued resistor from Pin 17 to Pin 18. Values below 120 k $\Omega$  are not recommended as the input signal cannot overcome the hysteresis.

The meter drive circuitry detects input signal level by monitoring the limiting of the limiting amplifier stages. Figure 5 shows the unloaded current at Pin 12 versus input power. The meter drive current can be used directly (RSSI) or can be used to trip the carrier detect circuit at a specified input power.

A muting op amp is provided and can be triggered by the carrier detect output (Pin 13). This provides a carrier level triggered squelch circuit which is activated when the RF input at the desired input frequency falls below a present level. The level at which this occurs is determined by the resistor placed between the meter drive output (Pin 12) and  $V_{CC}$ . Values between 80–130 k $\Omega$  are recommended. This type of squelch is pictured in Figures 3 and 4.

Hysteresis is available by connecting a high-valued resistor  $R_h$  between Pins 12 and 13. The formula is:

$$\text{Hyst} = V_{CC} / (R_h \times 10^{-7}) \text{ dB}$$

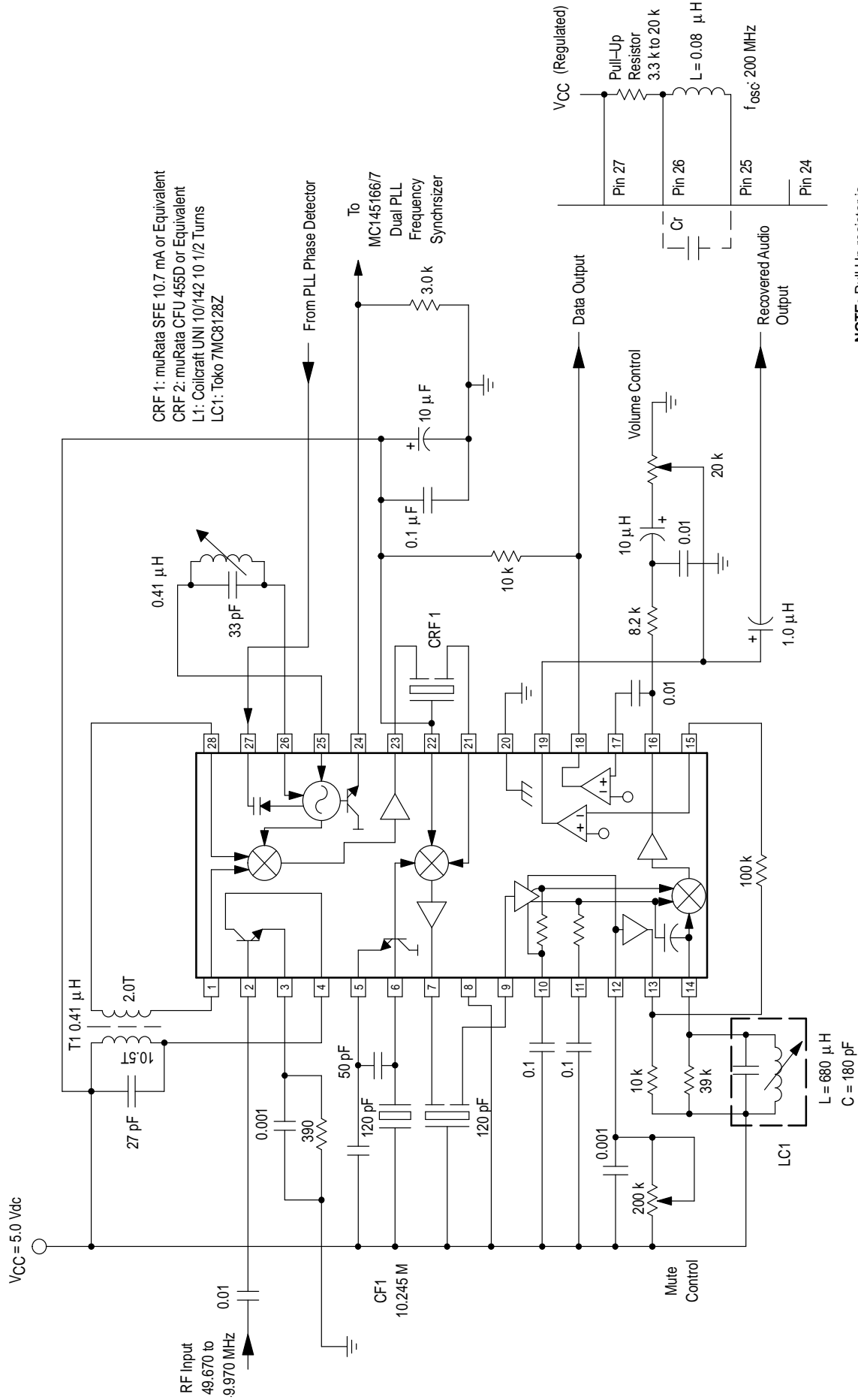
The meter drive can also be used directly to drive a meter or to provide AGC. A current to voltage converter or other linear buffer will be needed for this application.

A second possible application of the op amp would be in a noise triggered squelch circuit, similar to that used with the MC3357/MC3359/MC3361B FM IFs. In this case the op amp would serve as an active noise filter, the output of which would be rectified and compared to a reference on a squelch gate. The MC3363 does not have a dedicated squelch gate, but the NPN RF input stage or data shaping comparator might be used to provide this function if available. The op amp is a basic type with the inverting input and the output available. This application frees the meter drive to allow it to be used as a linear signal strength monitor.

The circuit of Figure 4 is a complete 50 MHz receiver from antenna input to audio preamp output. It uses few components and has good performance. The receiver operates on a single channel and has input sensitivity of < 0.3  $\mu$ V for 12 dB SINAD.

**NOTE:** For further application and design information, refer to AN980.

Figure 3. Typical Application in a PLL Frequency Synthesized Receiver



**NOTE:** Pull Up resistor is used to run the oscillator above 50 MHz.

Figure 4. Single Channel Narrowband FM Receiver at 49.67 MHz

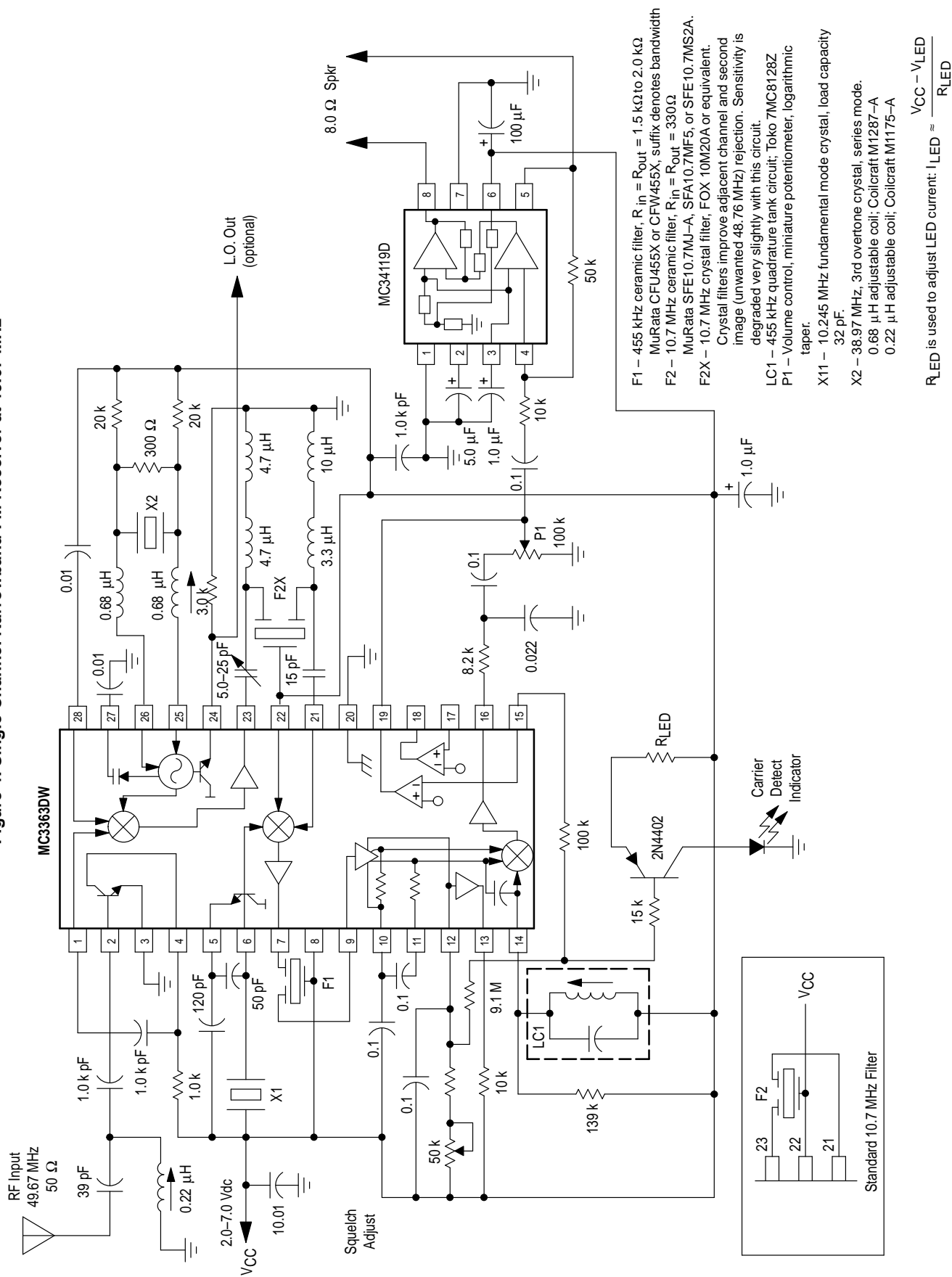


Figure 5. Circuit Schematic

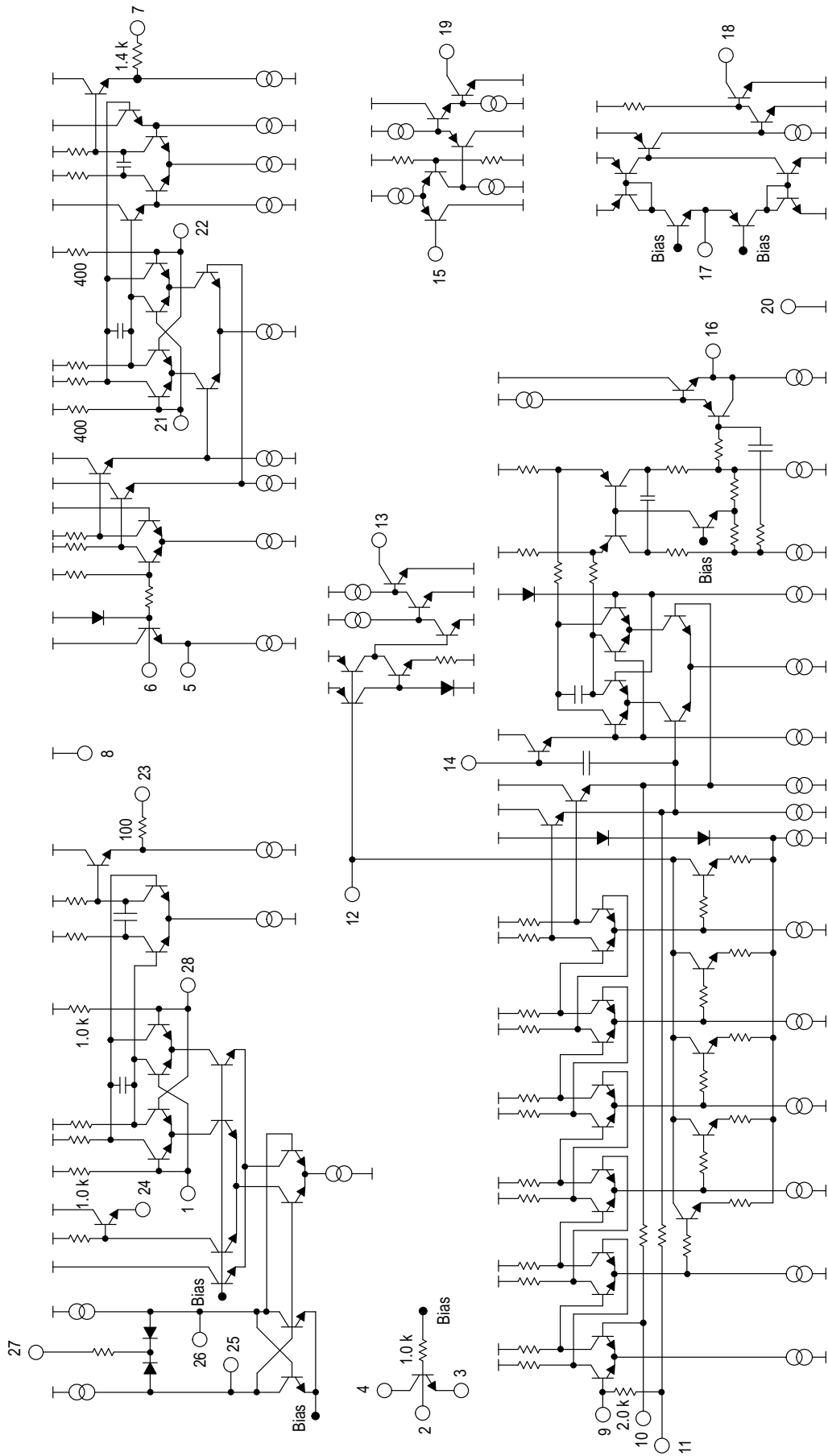


Figure 6. PC Board Component View with High Performance Crystal Filter

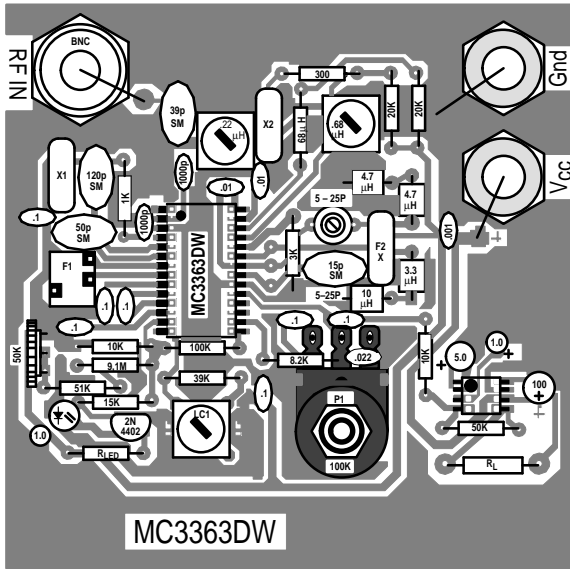


Figure 7. PC Board Circuit Side View

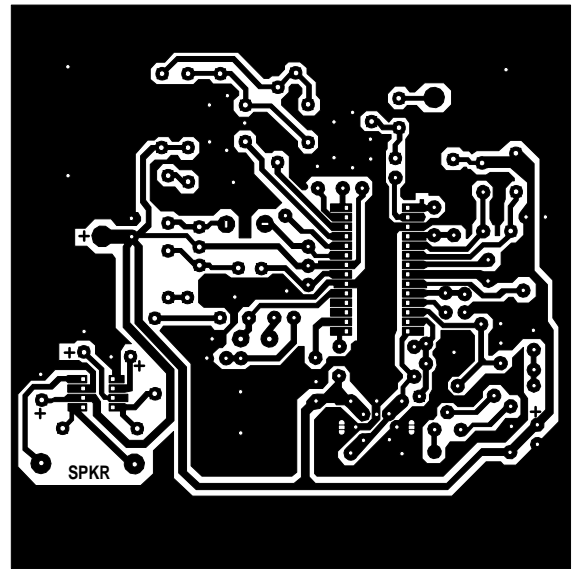
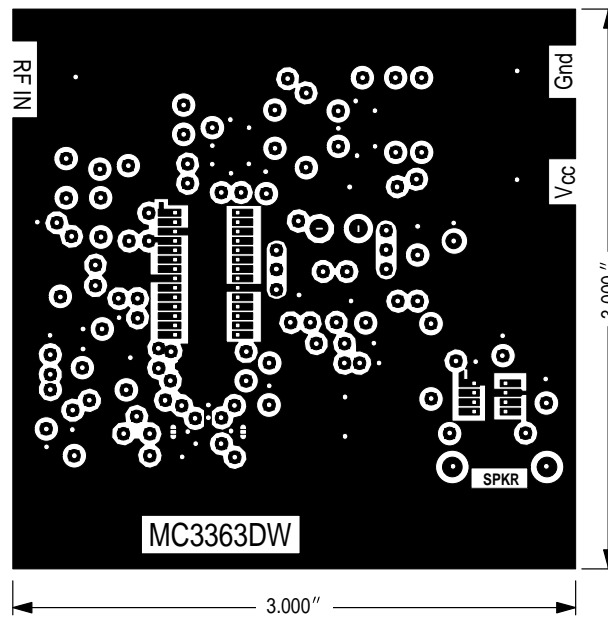


Figure 8. PC Board Component Side Ground Plane

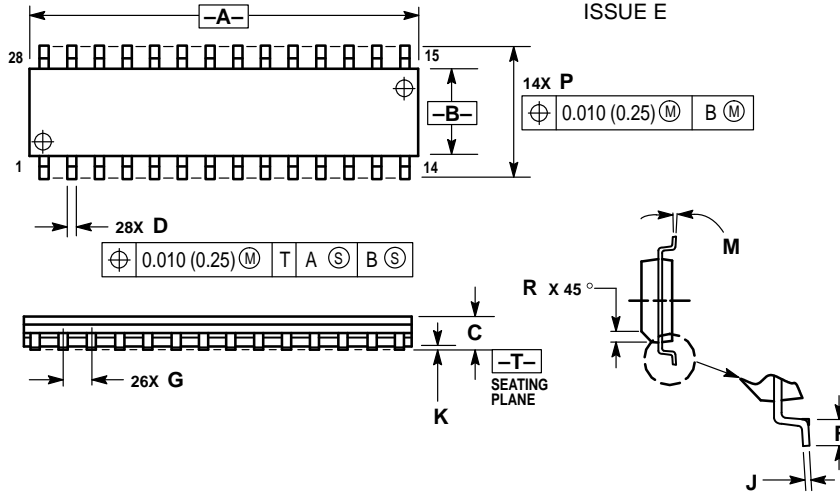




# MC3363


## OUTLINE DIMENSIONS

DW SUFFIX  
 PLASTIC PACKAGE  
 CASE 751F-04  
 (SO-28L)  
 ISSUE E



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 (0.005) TOTAL IN EXCESS OF D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	17.80	18.05	0.701	0.711
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.41	0.90	0.016	0.035
G	1.27 BSC		0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.13	0.29	0.005	0.011
M	0°	8°	0°	8°
P	10.01	10.55	0.395	0.415
R	0.25	0.75	0.010	0.029

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