LAMPIRAN

National Semiconductor

LM158/LM258/LM358, LM158A/LM258A/LM358A, LM2904 Low Power Dual Operational Amplifiers

General Description

The LM158 series consists of two independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM158 series can be directly operated off of the standard +5 V_{DC} power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15 V_{DC} power supplies.

Unique Characteristics

- In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.
- The unity gain cross frequency is temperature compensated.
- The input bias current is also temperature compensated.

Advantages

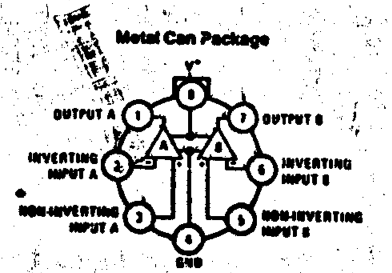
- Eliminates need for dual supplies
- Two internally compensated op amps in a single package
- Allows directly sensing near GND and V_{OUT} also goes to GND
- Compatible with all forms of logic
- Power drain suitable for battery operation
- Pin-out same as LM1558/LM1458 dual operational amplifier

Features

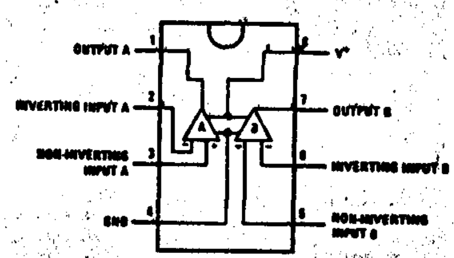
- Internally frequency compensated for unity gain
- Large dc voltage gain: 100 dB
- Wide bandwidth (unity gain) (temperature compensated): 1 MHz
- Wide power supply range:
  - Single supply: 3 V_{DC} to 32 V_{DC}
  - or dual supplies: ±1.5 V_{DC} to ±16 V_{DC}
- Very low supply current drain (500 μA)—essentially independent of supply voltage
- Low input biasing current (temperature compensated): 45 nA_{DC}
- Low input offset voltage: 2 mV_{DC}
- and offset current: 5 nA_{DC}
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing: 0 V_{DC} to V+ − 1.5 V_{DC}

Connection Diagrams (Top Views)

Metal Can Package



Order Number LM158AH, LM158H, LM258AH, LM258H, LM358AH or LM358H
See NS Package Number H08C



Order Number LM158J, LM158AJ or LM358J
See NS Package Number J08A
Order Number LM358M, LM358AM or LM2904M
See NS Package Number M08A
Order Number LM358AN, LM358N or LM2904N
See NS Package Number N08E

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications. (Note 9)

	LM158/LM258/LM358 LM158A/LM258A/LM358A	LM2904
Supply Voltage, V+	32 V_{DC} or ±16 V_{DC}	26 V_{DC} or ±13 V_{DC}
Differential Input Voltage	32 V_{DC}	26 V_{DC}
Input Voltage	−0.3 V_{DC} to +32 V_{DC}	−0.3 V_{DC} to +26 V_{DC}
Power Dissipation (Note 1)		
Molded DIP (LM358N)	830 mW	830 mW
Metal Can (LM158H/LM258H/LM358H)	550 mW	
Small Outline Package	530 mW	530 mW
Output Short-Circuit to GND (One Amplifier) (Note 2) V+ ≤ 15 V_{DC} and T_A = 25°C	Continuous	Continuous
Input Current (V_{IN} < −0.3 V_{DC}) (Note 3)	50 mA	50 mA

	LM158/LM258/LM358 LM158A/LM258A/LM358A	LM2904
Operating Temperature Range		−40°C to +85°C
LM358	0°C to +70°C	
LM258	−25°C to +85°C	
LM158	−55°C to +125°C	
Storage Temperature Range	−65°C to +150°C	−65°C to +150°C
Lead Temperature, DIP (Soldering, 10 seconds)	260°C	260°C
Lead Temperature, Metal Can (Soldering, 10 seconds)	300°C	300°C
Soldering Information		
Dual-In-Line Package Soldering (10 seconds)	260°C	260°C
Small Outline Package Vapor Phase (60 seconds)	215°C	215°C
Infrared (15 seconds)	220°C	220°C
ESD Tolerance (Note 10)	250V	250V

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

Electrical Characteristics V+ = +5.0 V_{DC}, unless otherwise stated

Parameter	Conditions	LM158A Min	LM158A Typ	LM158A Max	LM258A Min	LM258A Typ	LM258A Max	LM358A Min	LM358A Typ	LM358A Max	LM158/LM258 Min	LM158/LM258 Typ	LM158/LM258 Max	LM358 Min	LM358 Typ	LM358 Max	LM2904 Min	LM2904 Typ	LM2904 Max	Units
Input Offset Voltage	(Note 5), T_A = 25°C		±1	±2		±1	±3		±2	±3		±2	±5		±2	±7		±2	±7	mV_{DC}
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$, T_A = 25°C, V_{CM} = 0V, (Note 6)		20	50		40	80		45	100		45	150		45	250		45	250	nA_{DC}
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$, V_{CM} = 0V, T_A = 25°C		±2	±10		±2	±15		±5	±30		±3	±30		±5	±50		±5	±50	nA_{DC}
Input Common-Mode Voltage Range	V+ = 30 V_{DC}, (Note 7) (LM2904, V+ = 26V), T_A = 25°C	0		V+ −1.5	0		V+ −1.5	0		V+ −1.5	0		V+ −1.5	0		V+ −1.5	0		V+ −1.5	V_{DC}
Supply Current	Over Full Temperature Range, R_L = ∞ on All Op Amps, V+ = 30V (LM2904 V+ = 26V)		1	2		1	2		1	2		1	2		1	2		1	2	mA_{DC}
	V+ = 5V		0.5	1.2		0.5	1.2		0.5	1.2		0.5	1.2		0.5	1.2		0.5	1.2	mA_{DC}

Electrical Characteristics (Continued) $V^+ = +5.0\ V_{DC}$, Note 4, unless otherwise stated

Parameter	Conditions	LM158A			LM258A			LM358A			LM158/LM258			LM358			LM2904			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Large Signal Voltage Gain	$V^+ = 15\ V_{DC}$, $T_A = 25°C$, $R_L \geq 2\ k\Omega$, (For $V_O = 1\ V_{DC}$ to $11\ V_{DC}$)	50	100		50	100		25	100		50	100		25	100		25	100		V/mV
Common-Mode Rejection Ratio	DC, $T_A = 25°C$, $V_{CM} = 0V$ to $V^+ - 1.5\ V_{DC}$	70	85		70	85		65	85		65	85		65	85		50	70		dB
Power Supply Rejection Ratio	DC, $V^+ = 5\ V_{DC}$ to $30\ V_{DC}$ (LM2904, $V^+ = 5\ V_{DC}$ to $26\ V_{DC}$), $T_A = 25°C$	65	100		65	100		65	100		65	100		65	100		50	100		dB
Amplifier-to-Amplifier Coupling	f = 1 kHz to 20 kHz, $T_A = 25°C$ (Input Referred), (Note 8)		−120			−120			−120			−120			−120			−120		dB
Output Current Source	$V_{IN}^+ = 1\ V_{DC}$, $V_{IN}^- = 0\ V_{DC}$, $V^+ = 15\ V_{DC}$, $V_O = 2\ V_{DC}$, $T_A = 25°C$	20	40		20	40		20	40		20	40		20	40		20	40		mA_{DC}
Sink	$V_{IN}^- = 1\ V_{DC}$, $V_{IN}^+ = 0\ V_{DC}$, $V^+ = 15\ V_{DC}$, $T_A = 25°C$, $V_O = 2\ V_{DC}$	10	20		10	20		10	20		10	20		10	20		10	20		mA_{DC}
	$V_{IN}^- = 1\ V_{DC}$, $V_{IN}^+ = 0\ V_{DC}$, $T_A = 25°C$, $V_O = 200\ mV_{DC}$, $V^+ = 15\ V_{DC}$	12	50		12	50		12	50		12	50		12	50		12	50		μA_{DC}
Short Circuit to Ground	$T_A = 25°C$, (Note 2), $V^+ = 15\ V_{DC}$		40	60		40	60		40	60		40	60		40	60		40	60	mA_{DC}
Input Offset Voltage	(Note 5)			±4			±4			±5			±7			±9			±10	mV_{DC}
Input Offset Voltage Drift	$R_S = 0\Omega$		7	15		7	15		7	20		7			7			7		μV/°C
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$			±30			±30			±75			±100			±150		±45	±200	nA_{DC}
Input Offset Current Drift	$R_S = 0\Omega$		10	200		10	200		10	300		10			10			10		$pA_{DC}/°C$
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$		40	100		40	100		40	200		40	300		40	500		40	500	nA_{DC}

Electrical Characteristics (Continued) $V^+ = +5.0\ V_{DC}$, Note 4, unless otherwise stated

Parameter	Conditions	LM158A			LM258A			LM358A			LM158/LM258			LM358			LM2904			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Common-Mode Voltage Range	$V^+ = 30\ V_{DC}$, (Note 7) (LM2904, $V^+ = 26\ V_{DC}$)	0		V+ −2	0		V+ −2	0		V+ −2	0		V+ −2	0		V+ −2	0		V+ −2	V_{DC}
Large Signal Voltage Gain	$V^+ = +15\ V_{DC}$ ($V_O = 1\ V_{DC}$ to $11\ V_{DC}$) $R_L \geq 2\ k\Omega$	25			25			15			25			15			15			V/mV
Output Voltage Swing V_{OH}	$V^+ = +30\ V_{DC}$, $R_L = 2\ k\Omega$	26			26			26			26			26			22			V_{DC}
	$R_L \geq 10\ k\Omega$ (LM2904, $V^+ = 26\ V_{DC}$)	27	28		27	28		27	28		27	28		27	28		23	24		V_{DC}
V_{OL}	$V^+ = 5\ V_{DC}$, $R_L \geq 10\ k\Omega$		5	20		5	20		5	20		5	20		5	20		5	100	mV_{DC}
Output Current Source	$V_O = 2\ V_{DC}$, $V_{IN}^+ = +1\ V_{DC}$, $V_{IN}^- = 0\ V_{DC}$, $V^+ = 15\ V_{DC}$	10	20		10	20		10	20		10	20		10	20		10	20		mA_{DC}
Sink	$V_{IN}^- = +1\ V_{DC}$, $V_{IN}^+ = 0\ V_{DC}$, $V^+ = 15\ V_{DC}$	10	15		5	8		5	8		5	8		5	8		5	8		mA_{DC}

Note 1: For operating at high temperatures, the LM358/LM358A, LM2904 must be derated based on a +125°C maximum junction temperature and a thermal resistance of 120°C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. The LM258/LM258A and LM158/LM158A can be derated based on a +150°C maximum junction temperature. The dissipation is the total of both amplifiers—use external resistors, where possible, to allow the amplifier to saturate or to reduce the power which is dissipated in the integrated circuit.

Note 2: Short circuits from the output to V+ can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 40 mA independent of the magnitude of V+. At values of supply voltage in excess of +15 V_{DC}, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

Note 3: This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than −0.3 V_{DC} (at 25°C).

Note 4: These specifications are limited to $-55°C \leq T_A \leq +125°C$ for the LM158/LM158A. With the LM258/LM258A, all temperature specifications are limited to $-25°C \leq T_A \leq +85°C$, the LM358/LM358A temperature specifications are limited to $0°C \leq T_A \leq +70°C$, and the LM2904 specifications are limited to $-40°C \leq T_A \leq +85°C$.

Note 5: $V_O \approx 1.4\ V_{DC}$, $R_S = 0\Omega$ with V+ from 5 V_{DC} to 30 V_{DC}; and over the full input common-mode range (0 V_{DC} to V+ − 1.5 V_{DC}) at 25°C. For LM2904, V+ from 5 V_{DC} to 26 V_{DC}.

Note 6: The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

Note 7: The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (at 25°C). The upper end of the common-mode voltage range is V+ −1.5V (at 25°C), but either or both inputs can go to +32 V_{DC} without damage (+26 V_{DC} for LM2904), independent of the magnitude of V+.

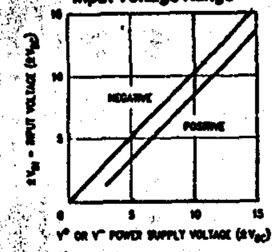
Note 8: Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

Note 9: Refer to RETS158AX for LM158A military specifications and to RETS158X for LM158 military specifications.

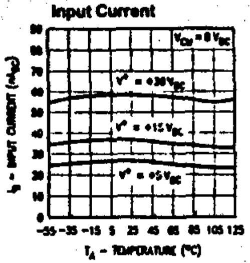
Note 10: Human body model, 1.5 kΩ in series with 100 pF.

Typical Performance Characteristics

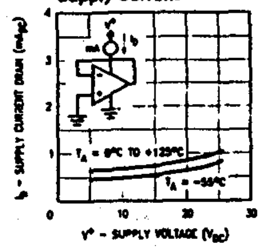
Input Voltage Range



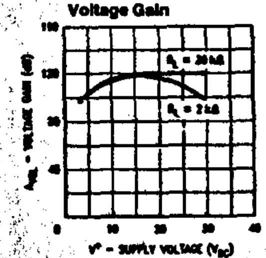
Input Current



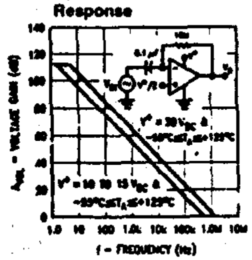
Supply Current



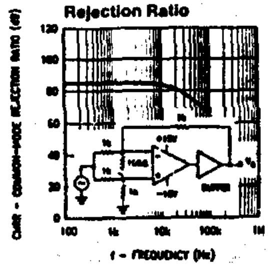
Voltage Gain



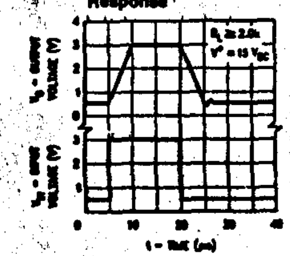
Open Loop Frequency Response



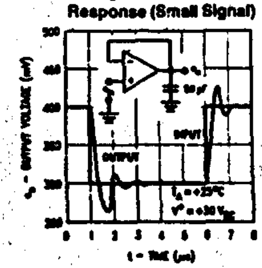
Common-Mode Rejection Ratio



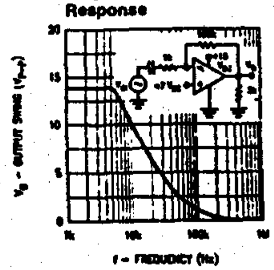
Voltage Follower Pulse Response



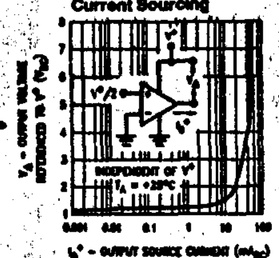
Voltage Follower Pulse Response (Small Signal)



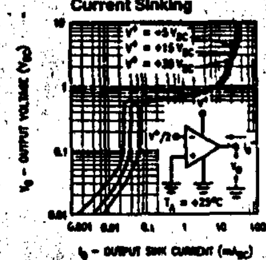
Large Signal Frequency Response



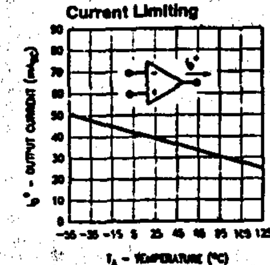
Output Characteristics Current Sourcing



Output Characteristics Current Sinking



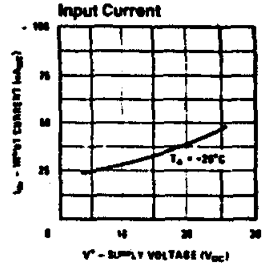
Current Limiting



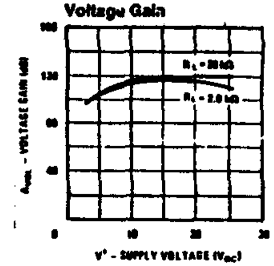
TL/H/7787–4

Typical Performance Characteristics (Continued) (LM2902 only)

Input Current



Voltage Gain



TL/H/7787–5

Application Hints

The LM158 series are op amps which operate with only a single power supply voltage, have true-differential inputs, and remain in the linear mode with an input common-mode voltage of 0 V_{DC}. These amplifiers operate over a wide range of power supply voltage with little change in performance characteristics. At 25°C amplifier operation is possible down to a minimum supply voltage of 2.3 V_{DC}.

Precautions should be taken to insure that the power supply for the integrated circuit never becomes reversed in polarity or that the unit is not inadvertently installed backwards in a test socket as an unlimited current surge through the resulting forward diode within the IC could cause fusing of the internal conductors and result in a destroyed unit.

Large differential input voltages can be easily accomodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V^+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than -0.3 V_{DC} (at 25°C). An input clamp diode with a resistor to the IC input terminal can be used.

To reduce the power supply current drain, the amplifiers have a class A output stage for small signal levels which converts to class B in a large signal mode. This allows the amplifiers to both source and sink large output currents. Therefore both NPN and PNP external current boost transistors can be used to extend the power capability of the basic amplifiers. The output voltage needs to raise approximately 1 diode drop above ground to bias the on-chip vertical PNP transistor for output current sinking applications.

For ac applications, where the load is capacitively coupled to the output of the amplifier, a resistor should be used, from the output of the amplifier to ground to increase the class A bias current and prevent crossover distortion. Where the load is directly coupled, as in dc applications, there is no crossover distortion.

Capacitive loads which are applied directly to the output of the amplifier reduce the loop stability margin. Values of 50 pF can be accomodated using the worst-case non-inverting unity gain connection. Large closed loop gains or resistive isolation should be used if larger load capacitance must be driven by the amplifier.

The bias network of the LM158 establishes a drain current which is independent of the magnitude of the power supply voltage over the range of 3 V_{DC} to 30 V_{DC}.

Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive function temperatures. Putting direct short-circuits on more than one amplifier at a time will increase the total IC power dissipation to destructive levels, if not properly protected with external dissipation limiting resistors in series with the output leads of the amplifiers. The larger value of output source current which is available at 25°C provides a larger output current capability at elevated temperatures (see typical performance characteristics) than a standard IC op amp.

The circuits presented in the section on typical applications emphasize operation on only a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used. In general, introducing a pseudo-ground (a bias voltage reference of $V^+/2$) will allow operation above and below this value in single power supply systems. Many application circuits are shown which take advantage of the wide input common-mode voltage range which includes ground. In most cases, input biasing is not required and input voltages which range to ground can easily be accommodated.

Table 6

Powdered-Iron Toroidal Cores—A_L Values (μH per 100 turns)

Core Size	41-Mix Green μ = 75 - - -	3-Mix Grey μ = 35 0.05-5 MHz	15-Mix Rd & Wh μ = 25 0.1-2 MHz	1-Mix Blue μ = 20 0.5-5 MHz	2-Mix Red μ = 10 2-30 MHz	6-Mix Yellow μ = 8 10-50 MHz	10-Mix Black μ = 6 30-100 MHz	12-Mix Gn & Wh μ = 3 50-200 MHz	0-Mix Tan μ = 1 100-300
T-200	755	425	NA	250	120	100	NA	NA	NA
T-184	1640	720	NA	500	240	195	NA	NA	NA
T-157	970	420	360	320	140	115	NA	NA	NA
T-130	785	350	250	200	110	96	NA	NA	15.0
T-106	900	450	345	325	135	116	NA	NA	19.0
T-94	590	248	200	160	84	70	58	32	10.6
T-80	450	180	170	115	55	45	32	22	8.5
T-68	420	195	180	115	57	47	32	21	7.5
T-50	320	175	135	100	49	46	31	18	6.4
T-44	229	180	160	105	52	42	33	18.5	6.5
T-37	308	120	90	80	40	30	25	15	4.9
T-30	375	140	93	85	43	36	25	16	6.0
T-25	225	100	85	70	34	27	19	12	4.5
T-20	175	76	65	52	25	22	16	10	3.5
T-16	130	61	55	44	22	19	13	8	3.0
T-12	112	60	50	48	20	17	12	7.5	3.0

NA—Not available in that size.

Turns = 100 $\sqrt{L_{\mu}H \div A_L \text{ value (above)}}$

All frequency figures optimum.

Number of Turns vs. Wire Size and Core Size

Approximate maximum of turns—single-layer-wound enameled wire

Wire Size	T-200	T-130	T-106	T-94	T-80	T-68	T-50	T-37	T-25	T-12
10	31	17	10	10	8	7	5	1	1	0
12	41	23	14	14	12	9	6	3	1	0
14	53	30	20	20	17	12	8	5	1	0
16	68	40	27	27	23	15	11	7	3	1
18	86	51	35	35	30	21	16	9	4	1
20	109	66	45	45	39	28	21	12	5	1
22	139	83	58	58	51	36	28	17	7	2
24	176	107	75	75	66	47	37	23	11	4
26	223	137	96	96	84	61	49	31	15	5
28	282	173	123	123	108	79	63	41	21	8
30	357	220	156	156	137	101	81	53	28	11
32	445	275	195	195	172	127	103	67	37	15
34	562	348	248	248	219	162	131	87	48	21
36	707	439	313	313	276	205	166	110	62	29
38	886	550	393	393	347	257	210	140	79	37
40	1115	693	496	496	438	325	265	177	101	47

Physical Dimensions

Core Size	Outer Dia (in)	Inner Dia (in)	Height (in)	Cross Sect. Area (cm^2)	Mean Length (cm)	Core Size	Outer Dia (in)	Inner Dia (in)	Height (in)	Cross Sect. Area (cm^2)	Mean Length (cm)
T-200	2.000	1.250	0.550	1.330	12.97	T-50	0.500	0.303	0.190	0.121	3.20
T-184	1.840	0.950	0.710	2.040	11.12	T-44	0.440	0.229	0.159	0.107	2.67
T-157	1.570	0.950	0.570	1.140	10.05	T-37	0.375	0.205	0.128	0.070	2.32
T-130	1.300	0.780	0.437	0.733	8.29	T-30	0.307	0.151	0.128	0.065	1.83
T-106	1.060	0.570	0.437	0.690	6.50	T-25	0.255	0.120	0.096	0.042	1.50
T-94	0.942	0.560	0.312	0.385	6.00	T-20	0.200	0.088	0.070	0.025	1.15
T-80	0.795	0.495	0.250	0.242	5.15	T-16	0.160	0.078	0.060	0.016	0.95
T-68	0.690	0.370	0.190	0.196	4.24	T-12	0.125	0.062	0.050	0.010	0.75

Courtesy of Amidon Assoc. and Micrometals, Inc.

Table 7
Ferrite Toroids A_L **— Chart (mH per 1000 turns) Enameled Wire**

Core Size	*63-Mix* μ=40	*61-Mix* μ=125	*43-Mix* μ=950	*72-Mix* μ=2000	*75-Mix* μ=5000
FT- 23	7.9	24.8	189.0	396.0	990.0
FT- 37	17.7	55.3	420.0	884.0	2210.0
FT- 50	22.0	68.0	523.0	1100.0	2750.0
FT- 82	23.4	73.3	557.0	1172.0	2930.0
FT-114	25.4	79.3	603.0	1268.0	3170.0

Number turns $= 1000\sqrt{\text{desired L (mH)} \div A_L \text{ value (above)}}$

Ferrite Magnetic Properties

Property	*Unit*	*63-Mix*	*61-Mix*	*43-Mix*	*72-Mix*	*75-Mix*
Initial Perm. (μi)		40	125	950	2000	5000
Maximum Perm.		125	450	3000	3500	8000
Saturation Flux Density @ 13 oer	Gauss	1850	2350	2750	3500	3900
Residual Flux Density	Gauss	750	1200	1200	1500	1250
Curie Temp.	°C	500	300	130	150	160
Vol. Resistivity	ohm/cm	1 x 10^8	1 x 10^8	1 x 10^5	1 x 10^2	5 x 10^2
Opt. Freq. Range	MHz	15-25	.2-10	.01-1	.001-1	.001-1
Specific Gravity		4.7	4.7	4.5	4.8	4.8
Loss Factor	$\frac{1}{uQ}$	9.0 x 10^{-5} @ 25 MHz.	2.2 x 10^{-5} @ 2.5 MHz	2.5 x 10^{-5} @ .2 MHz	9.0 x 10^{-6} @ .1 MHz	5.0 x 10^{-6} @ .1 MHz
Coercive Force	Oer.	2.40	1.60	0.30	0.18	0.18
Temp. Co-eff of initial Perm.	%/°C 20-70°C	0.10	0.10	0.20	0.60	

Ferrite Toroids — Physical Properties

Core Size	*OD*	*ID*	*Height*	A_e	l_e	V_e	A_s	A_w
FT- 23	0.230	0.120	0.060	0.00330	0.529	0.00174	0.1264	0.01121
FT- 37	0.375	0.187	0.125	0.01175	0.846	0.00994	0.3860	0.02750
FT- 50	0.500	0.281	0.188	0.02060	1.190	0.02450	0.7300	0.06200
FT- 82	0.825	0.520	0.250	0.03810	2.070	0.07890	1.7000	0.21200
FT-114	1.142	0.748	0.295	0.05810	2.920	0.16950	2.9200	0.43900

OD - Outer diameter (inches)
ID - Inner diameter (inches)
Hgt - Height (inches)
A_w - Total window area (in)^2
A_e - Effective magnetic cross-sectional area (in)^2
l_e - Effective magnetic path length (inches)
V_e - Effective magnetic volume (in)^3
A_s - Surface area exposed for cooling (in)^2

Inches $\times$ 25.4 = mm. Courtesy of Amidon Assoc., N. Hollywood, CA 91607.

able 8

errite Toroid Cores — Size Cross-Reference

nches) D	ID	Thickness	Amidon	Fair-Rite	Indiana General	Ferroxcube	Magnetics, Inc.
100	0.050	0.050	——	——	——	——	40200TC
100	0.070	0.030	——	701	F426-1	——	——
155	0.088	——	——	801	F2062-1	——	40502
190	0.090	0.050	——	——	——	213T050	——
230	0.120	0.060	FT-23	101	F303-1	1041T060	40601
230	0.120	0.120	——	901	——	——	——
300	0.125	0.188	——	——	F867-1	——	40705
375	0.187	0.125	FT-37	201	F625-9	266T125	41003
500	0.281	0.188	FT-50	301	——	768T188	——
500	0.312	0.250	——	1101	F627-8	——	41306
500	0.312	0.500	——	1901	——	——	——
825	0.520	0.250	FT-82	601	——	——	——
825	0.520	0.468	——	501	——	——	——
870	0.500	0.250	——	401	——	——	——
870	0.540	0.250	——	1801	F624-19	846T250	42206
.000	0.500	0.250	——	1501	F2070-1	——	42507
.000	0.610	0.250	——	1301	——	——	——
.142	0.748	0.295	FT-114	1001	——	K300502	42908
.225	0.750	0.312	——	1601	——	——	——
.250	0.750	0.375	——	1701	F626-12	——	——
.417	0.905	0.591	——	——	——	K300501	——
.417	0.905	0.394	——	——	——	K300500	——
.500	0.750	0.500	——	——	——	528T500	43813
.000	1.250	0.750	——	——	——	400T750	——
.900	1.530	0.500	——	——	——	144T500	——
.375	1.925	0.500	——	——	F1707-15	——	——
.500	2.000	0.500	——	——	F1707-1	——	——
.835	2.50	0.625	——	——	F1824-1	——	——

able 9

errite Toroid Cores — Permeability Cross-Reference

μ_o	Amidon	Fair-Rite	Indiana General	Ferroxcube	Magnetics, Inc.
16	—	—	Q3	—	—
20	—	68	—	—	—
40	FT — 63	63, 67	Q2	—	—
100	—	65	—	—	—
125	FT — 61	61	Q1	4C4	—
175	—	62	—	—	—
250	FT — 64	64	—	—	—
300	—	83	—	—	—
375	—	31	—	—	—
400	—	—	G	—	—
750	—	—	—	3D3	A
800	—	33	—	—	
850	—	43	H	—	—
950	FT — 43	—	TC-3	—	—
1400	—	—	—	—	C
1200	—	34	—	—	—
1500	—	—	TC-7	—	—
1800	FT — 77	77	—	3B9	—
2000	FT — 72	72	TC-9	—	S, V, D
2200	—	—	05	—	—
2300	—	—	—	3B7	G
2500	FT — 73	73	TC-12	—	—
2700	—	—	—	3E (3C8)	—
3000	—	—	05P	3C5	F
4700	—	—	06	—	—
5000	FT — 75	75	—	3E2A	J
),000	—	—	—	—	W
2,500	—	—	—	3E3	—

ridge or an RX meter. If these instruments are not available, close approximations can be had by using a dip neter, standard capacitor (known value, able type, such as a silver mica) and a alibrated receiver against which to check ne dipper frequency. Fig. 56 shows how couple a dip meter to a completed oroid for testing. The coupling link in the illustration is necessary because the toroid has a self-shielding characteristic. The latter makes it difficult, and often impossible, to secure a dip in the meter reading when coupling the instrument directly to the toroidal inductor or transformer. The inductance can be determined by X_L since $X_L = X_c$ at resonance. Therefore,

Table 11

Copper Wire Specifications

Bare and Enamel-Coated Wire

Wire Size (AWG)	Diam (Mils)	Area (CM[1])	Enamel Wire Coating Turns/Linear inch[2] Single	Heavy	Triple	Feet per Pound Bare	Ohms per 1000 ft 25° C	Current Carrying Capacity Continuous Duty[3]: at 700 CM per Amp[4]	Open air	Conduit or bundles	Diam (mm)
1	289.3	83694.49				3.948	0.1239	119.564			7.348
2	257.6	66357.76				4.978	0.1563	94.797			6.543
3	229.4	52624.36				6.277	0.1971	75.178			5.827
4	204.3	41738.49				7.918	0.2485	59.626			5.189
5	181.9	33087.61				9.98	0.3134	47.268			4.620
6	162.0	26244.00				12.59	0.3952	37.491			4.115
7	144.3	20822.49				15.87	0.4981	29.746			3.665
8	128.5	16512.25				20.01	0.6281	23.589			3.264
9	114.4	13087.36				25.24	0.7925	18.696			2.906
10	101.9	10383.61				31.82	0.9987	14.834			2.588
11	90.7	8226.49				40.16	1.2610	11.752			2.304
12	80.8	6528.64				50.61	1.5880	9.327			2.052
13	72.0	5184.00				63.73	2.0010	7.406			1.829
14	64.1	4108.81	15.2	14.8	14.5	80.39	2.5240	5.870	32	17	1.628
15	57.1	3260.41	17.0	16.6	16.2	101.32	3.1810	4.658			1.450
16	50.8	2580.64	19.1	18.6	18.1	128	4.0180	3.687	22	13	1.290
17	45.3	2052.09	21.4	20.7	20.2	161	5.0540	2.932			1.151
18	40.3	1624.09	23.9	23.2	22.5	203.5	6.3860	2.320	16	10	1.024
19	35.9	1288.81	26.8	25.9	25.1	256.4	8.0460	1.841			0.912
20	32.0	1024.00	29.9	28.9	27.9	322.7	10.1280	1.463	11	7.5	0.813
21	28.5	812.25	33.6	32.4	31.3	406.7	12.7700	1.160			0.724
22	25.3	640.09	37.6	36.2	34.7	516.3	16.2000	0.914		5	0.643
23	22.6	510.76	42.0	40.3	38.6	646.8	20.3000	0.730			0.574
24	20.1	404.01	46.9	45.0	42.9	817.7	25.6700	0.577			0.511
25	17.9	320.41	52.6	50.3	47.8	1031	32.3700	0.458			0.455
26	15.9	252.81	58.8	56.2	53.2	1307	41.0200	0.361			0.404
27	14.2	201.64	65.8	62.5	59.2	1639	51.4400	0.288			0.361
28	12.6	158.76	73.5	69.4	65.8	2081	65.3100	0.227			0.320
29	11.3	127.69	82.0	76.9	72.5	2567	81.2100	0.182			0.287
30	10.0	100.00	91.7	86.2	80.6	3306	103.7100	0.143			0.254
31	8.9	79.21	103.1	95.2		4170	130.9000	0.113			0.226
32	8.0	64.00	113.6	105.3		5153	162.0000	0.091			0.203
33	7.1	50.41	128.2	117.6		6553	205.7000	0.072			0.180
34	6.3	39.69	142.9	133.3		8326	261.3000	0.057			0.160
35	5.6	31.36	161.3	149.3		10537	330.7000	0.045			0.142
36	5.0	25.00	178.6	166.7		13212	414.8000	0.036			0.127
37	4.5	20.25	200.0	181.8		16319	512.1000	0.029			0.114
38	4.0	16.00	222.2	204.1		20544	648.2000	0.023			0.102
39	3.5	12.25	256.4	232.6		26969	846.6000	0.018			0.089
40	3.1	9.61	285.7	263.2		34364	1079.2000	0.014			0.079
41	2.8	7.84	322.6	294.1		42123	1323.0000	0.011			0.071
42	2.5	6.25	357.1	333.3		52854	1659.0000	0.009			0.064
43	2.2	4.84	400.0	370.4		68259	2143.0000	0.007			0.056
44	2.0	4.00	454.5	400.0		82645	2593.0000	0.006			0.051
45	1.8	3.10	526.3	465.1		106600	3348.0000	0.004			0.045
46	1.6	2.46	588.2	512.8		134000	4207.0000	0.004			0.040

Teflon Coated, Stranded Wire

(As supplied by Belden Wire and Cable.)

Size	Strands[5]	Turns per Linear Inch[2] UL Style No. 1180	1213	1371
16	19 x 29	11.2		
18	19 x 30	12.7		
20	7 x 28	14.7	17.2	
20	19 x 32	14.7	17.2	

Size	Strands[5]	Turns per Linear Inch[2] UL Style No. 1180	1213	1371
22	19 x 34	16.7	20.0	23.8
22	7 x 30	16.7	20.0	23.8
24	19 x 36	18.5	22.7	27.8
24	7 x 32		22.7	27.8

Size	Strands[5]	Turns per Linear Inch[2] UL Style No. 1180	1213	[illegible]
26	7 x 24		25.6	[illegible]
28	7 x 36		28.6	[illegible]
30	7 x 38		31.3	[illegible]
32	7 x 40		[illegible]	[illegible]

[1]A circular mil (CM) is a unit of area equal to that of a one-mil-diameter circle (π/4 square mils). The CM area of a wire is the square of the [illegible]

[2]Figures given are approximate only; insulation thickness varies with manufacturer.

[3]Maximum wire temperature of 212° F (100° C) with a maximum ambient temperature of 135° F (57° C).

[4]700 CM per ampere is a satisfactory design figure for small transformers, but values from 500 to 1000 CM are commonly used

[5]Stranded wire construction is given as "count" x "strand size" (AWG).

KA22495 RF Front End Amplifier, Mixer and IF-Amplifier

Similar to AN7205 KA6058 KIA6058 LA1185 and TA7358AP

verview

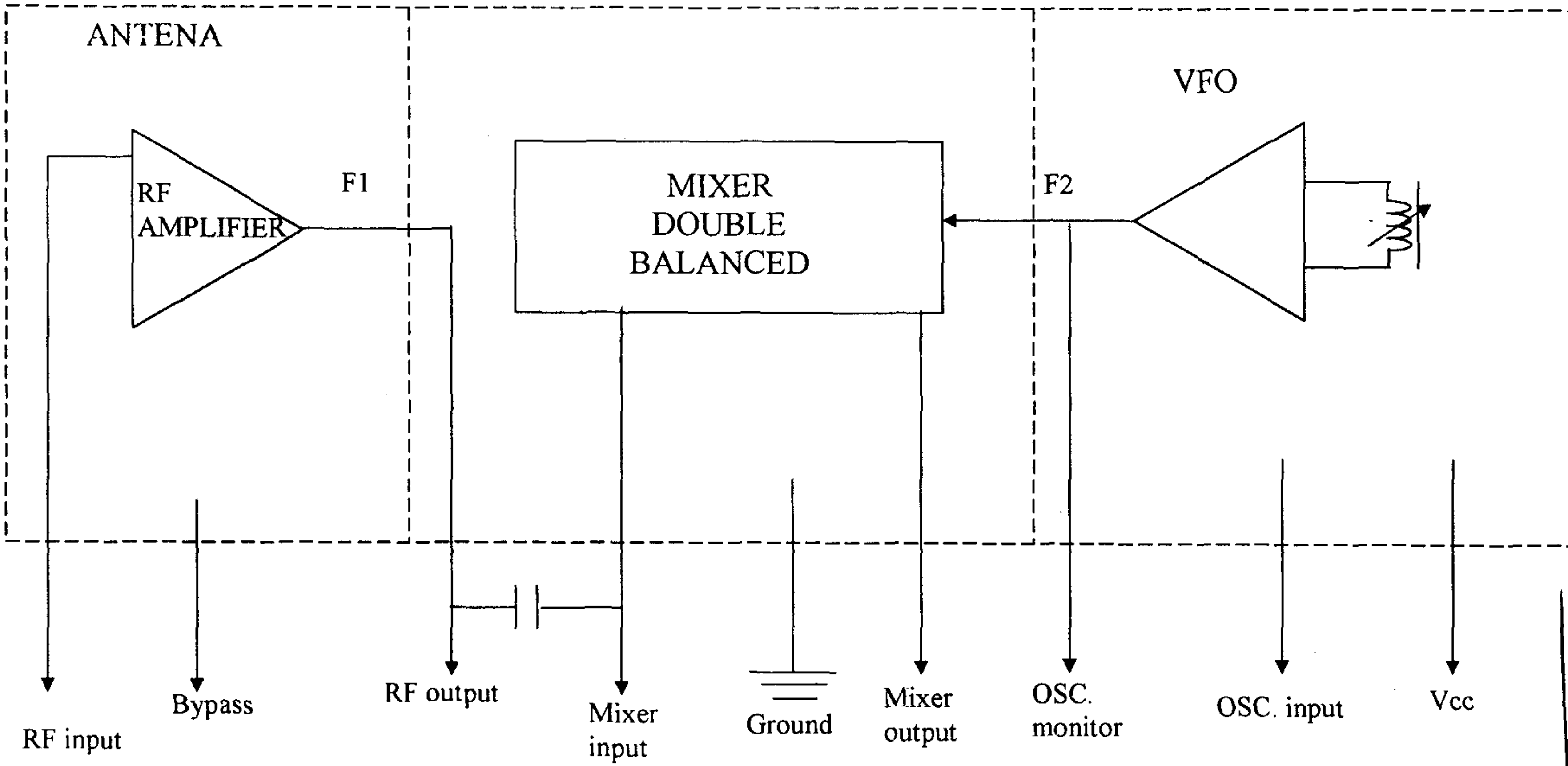
he LA1185 is an FM receiver front-end IC. Its mixer is of double-balanced type. The built-in oscillator and uffer amplifier improves the strong input characteristic.

unctions and Features

RF amplifier, mixer, local oscillator
Improvement in cross modulation characteristics due to the use of double-balanced mixer.
Improvement in strong input characteristic.
Minimum number of external parts required.
Less spurious radiation from local oscillator.
Operating voltage range : 1.5 to 8.0 V

Pin	Name	Description
1		RF Input
2		Bypass
3		RF Output
4		Mixer Input
5	GND	Ground
6		Mixer Output
7		Oscillator Monitor
8		Oscillator Input
9	Vcc	Positive Power Supply

CB Radio Banner Exchange



Gambar Rangkaian blok Ic TA7358 AP

PERPUSTAKAAN
Universitas Katolik Widya Mandala
SURABAYA