Ordering number : EN2276B

Monolithic Linear IC

# LA1175, 1175M

## FM Front End For Car Radio, Home Stereo Applications

## Functions

• Double-balanced type MIX, PIN diode drive AGC output, MOS FET gate drive AGC output, keyed AGC, differential IF amplifier, buffer amplifier for oscillation, local oscillation.

## Features

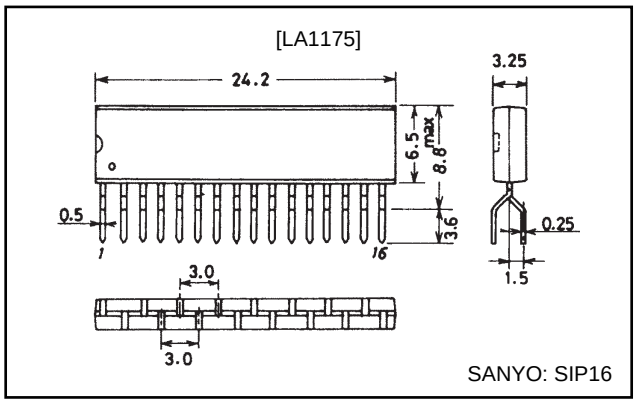
• By using the keyed AGC system, which is effective in improving the sensitivity suppression characteristic, in combination with the antenna damping AGC (PIN diode driver on chip) and MOS FET 2nd gate drive AGC, the intermodulation characteristic for a large undesired signal is greatly improved. It is also possible to use the keyed AGC system in combination with the antenna damping AGC or MOS FET 2nd gate drive AGC.

• The temperature characteristic and noise figure are improved. The same supply voltage makes it easy to use the LA1175, 1175M.

## Package Dimensions

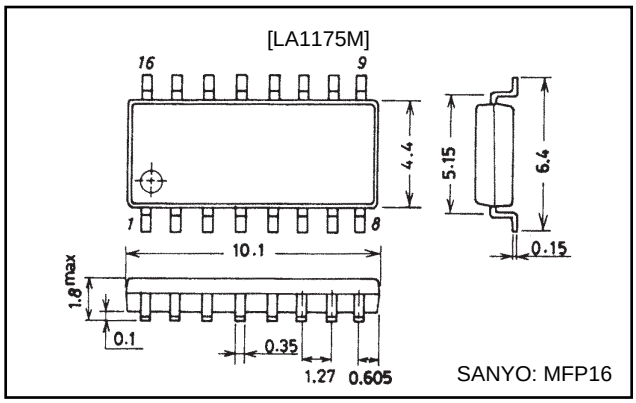
unit: mm

**3020A-SIP16**




unit: mm

**3035A-MFP16**




## Specifications

### Maximum Ratings at Ta=25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Maximum supply voltage | $V_{CC}$ max | Pins 4, 14 | 9.5 | V |
| | | Pins 8, 9 | 15 | V |
| Allowable power dissipation | Pd max | LA1175 : Ta≤70°C | 460 | mW |
| | | LA1175M : Ta≤70°C<br>Mounted on PCB (bakelite)<br>of 40mm×48mm×1.8mm$^2$ | 435 | mW |
| Operating temperature | Topr | | –20 to +70 | °C |
| Storage temperature | Tstg | | –40 to +125 | °C |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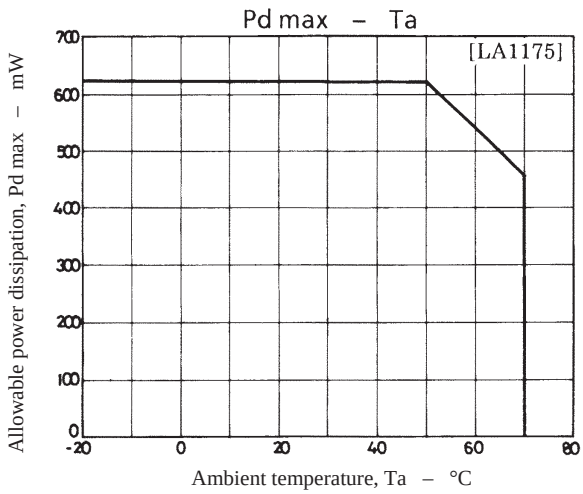
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110 JAPAN

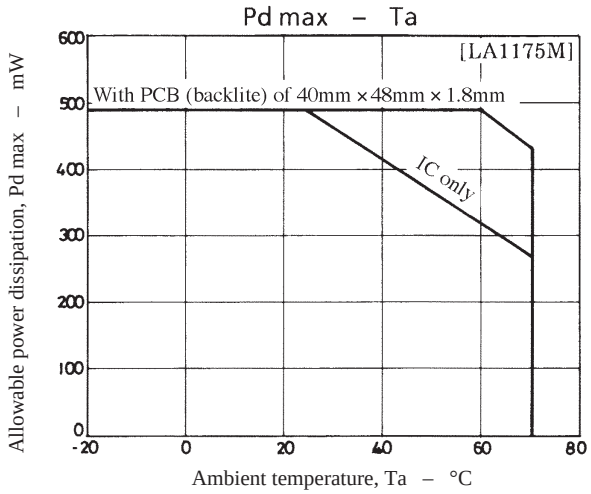
## Operating Conditions at Ta=25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Recommended supply voltage | $V_{CC}$ | Pin 4, 8, 9, 14 | 8 | V |
| Operating voltagerange | $V_{CC}$ op | | 8 to 9 | V |

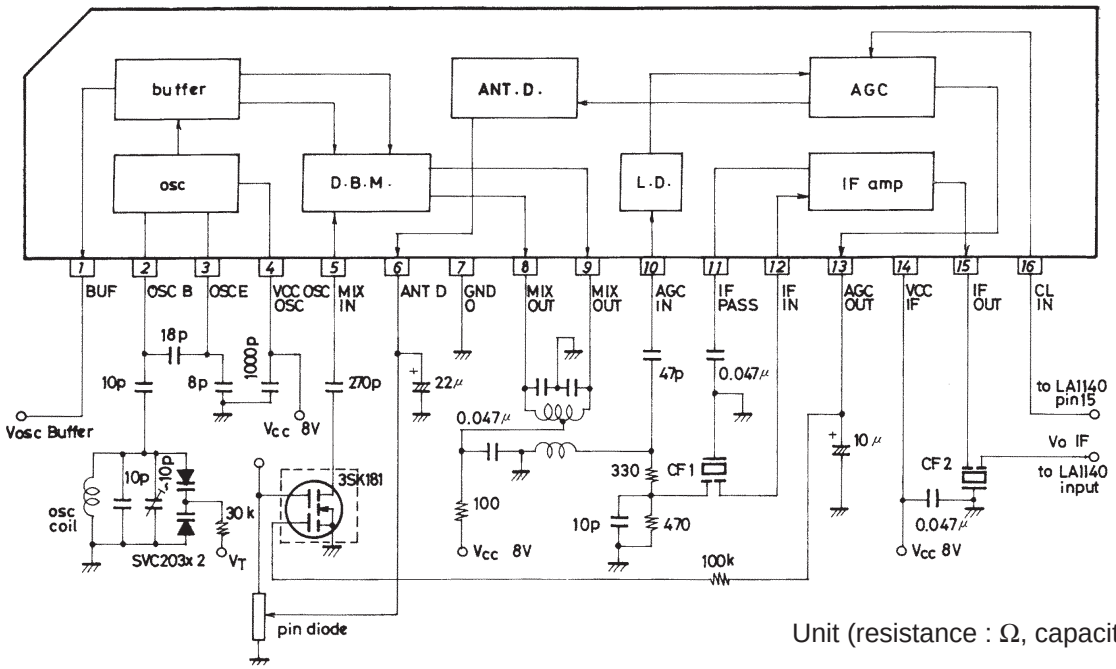
## Electrical Characteristics at Ta=25°C, $V_{CC}$=8V, See specified Test Circuit.

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Current drain | $I_{CC}$ | Pins 4, 8, 9, 14 : no input | 23.0 | 28.0 | 33.0 | mA |
| AGC high-level voltage | $V_{AGCH}$ | $V_{IN}$=0dBμ, $V_{CL}$=4V | 7.6 | 7.9 | | V |
| AGC low-level voltage | $V_{AGCL}$ | $V_{IN}$=100dBμ, $V_{CL}$=4V | | 0.2 | 0.7 | V |
| IF input resistance | $R_{IN}$ | | 260 | 330 | 400 | Ω |
| AGC control input | $V_{CL}7$ | $V_{IN}$=100dBμ, $V_{AGC}$=7V | | 0.25 | 0.5 | V |
| | $V_{CL}2$ | $V_{IN}$=100dBμ, $V_{AGC}$=2V | 1.1 | 1.6 | 2.1 | V |
| Voltage gain | $A_V$ | LA1175 : $V_{IN}$=75dBμ | 99 | 102 | 105 | dBμ |
| | | LA1175M : $V_{IN}$=75dBμ | 97 | 100 | 103 | dBμ |
| Input limiting voltage | $V_{INlim}$ | LA1175 : Referenced to $V_{IN}$=110dBμ | 81 | 88 | 95 | dBμ |
| | | LA1175M : Referenced to $V_{IN}$=110dBμ | 80 | 87 | 94 | dBμ |
| AGC input voltage | $V_{iAGC}$ | $V_{AGC}$=2V | 67 | 74 | 81 | dBμ |
| Saturation output voltage | $V_{OUT}$ | LA1175 : $V_{IN}$=110dBμ | 110 | 114 | | dBμ |
| | | LA1175M : $V_{IN}$=110dBμ | 100 | 113 | | dBμ |
| OSC BUFF output | $V_{OSC}$ BUFF | 1kΩ load | 105 | 109 | | dBμ |
| ANT damping drive current | $I_{ANT-D}$ | $V_{IN}$=100dBμ | 4.5 | 6.0 | 8.0 | mA |

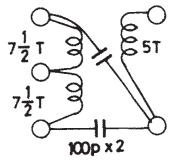


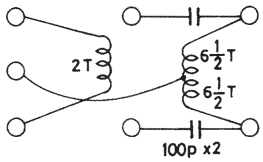
## Equivalent Circuit Block Diagram and Peripheral Circuit : LA1175




Unit (resistance : Ω, capacitance : F)

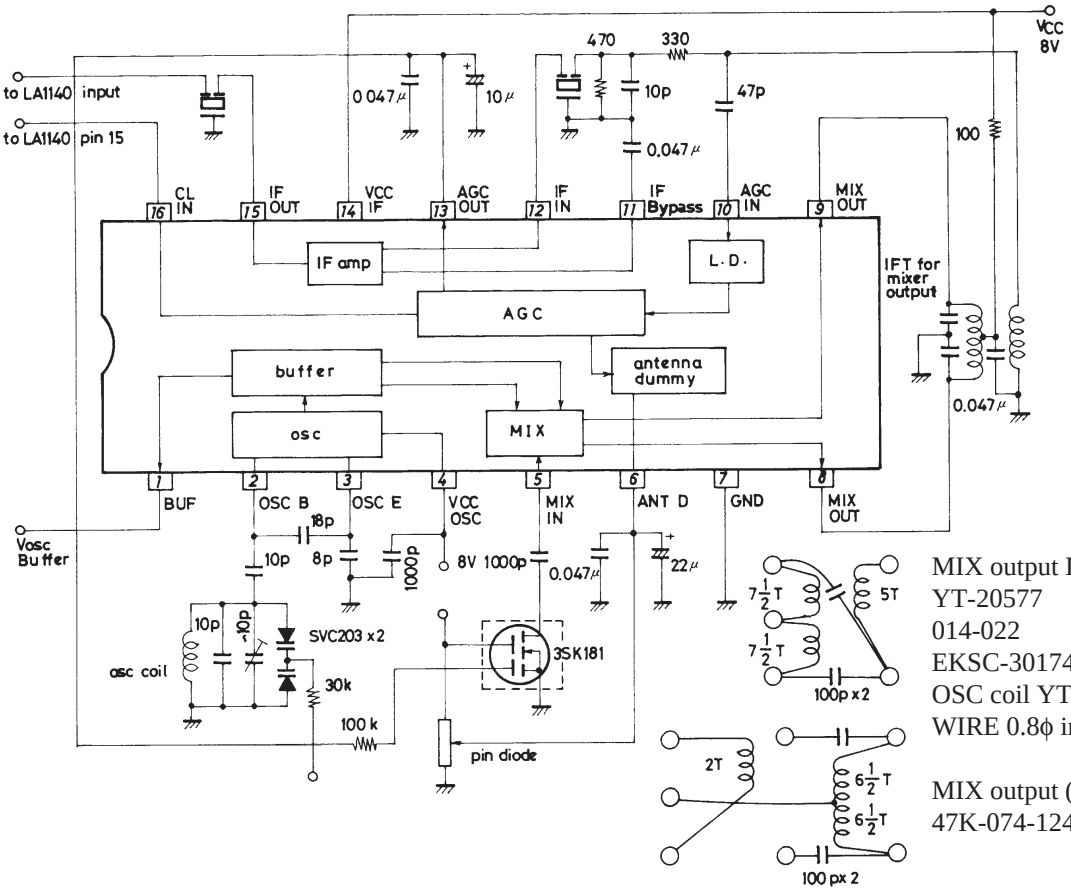



MIX output IFT 10mm □
YT-20577 (Mitsumi)
014-022 (Sumida)
EKSC-30174FCU (Toko)
OSC coil YT-30013 (Mitsumi)
WIRE 0.8ϕ inside dia. 6mmϕ 4T air core




MIX output (small-sized)
47K-074-124 (Sumida)

## Equivalent Circuit Block Diagram and Peripheral Circuit : LA1175M

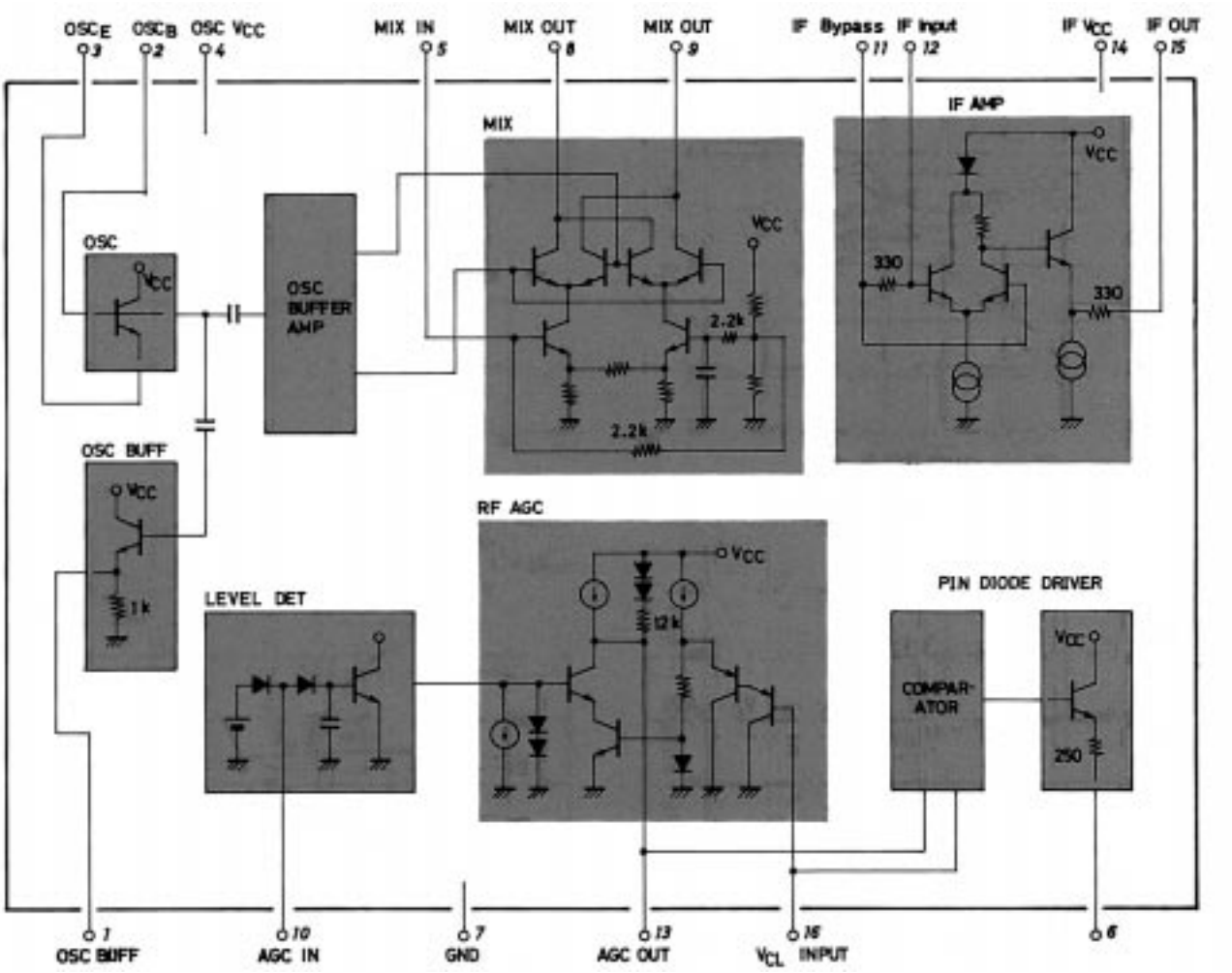



MIX output IFT 10mm □
YT-20577 (Mitsumi)
014-022 (Sumida)
EKSC-30174FCU (Toko)
OSC coil YT-30013 (Mitsumi)
WIRE 0.8ϕ inside dia. 6mmϕ 4T air core

MIX output (small-sized)
47K-074-124 (Sumida)

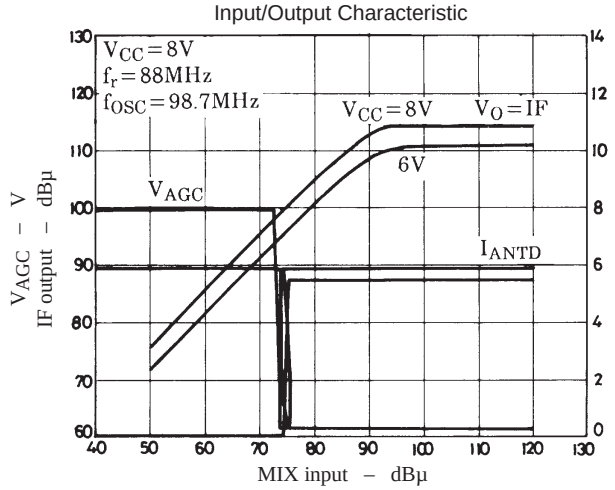
Unit (resistance : Ω, capacitance : F)

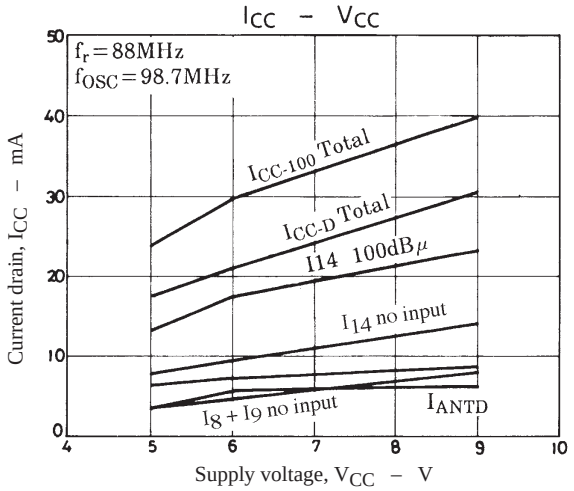
## Internal Connection Diagram : LA1175



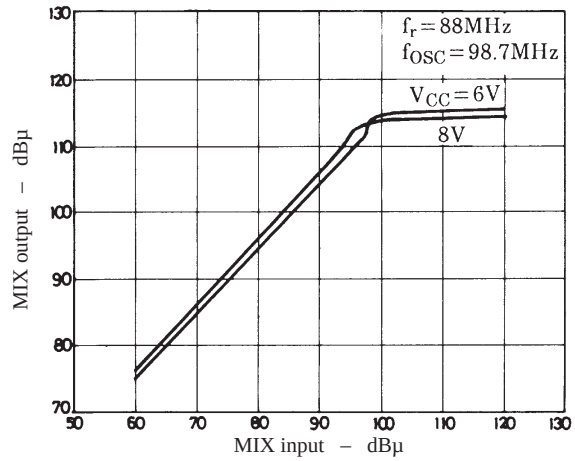

Unit (resistance : Ω, capacitance : F)

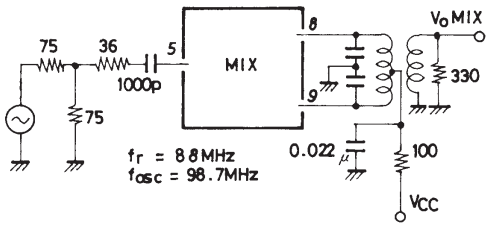
Input/Output Characteristic



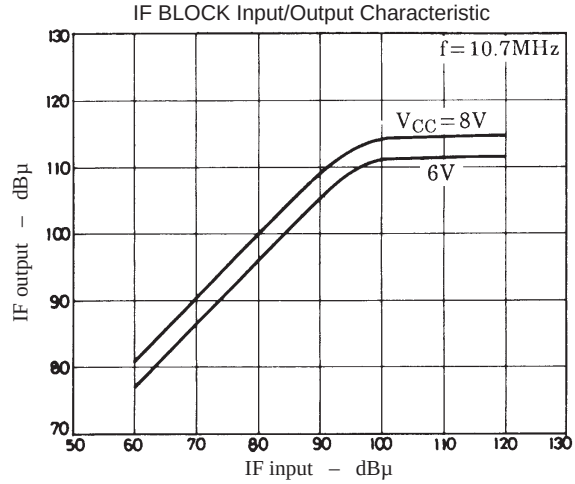
MIX BLOCK Input/Output Characteristic

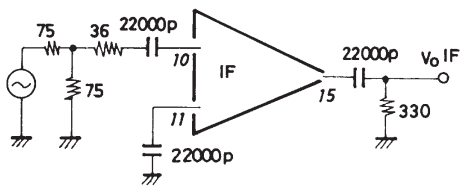


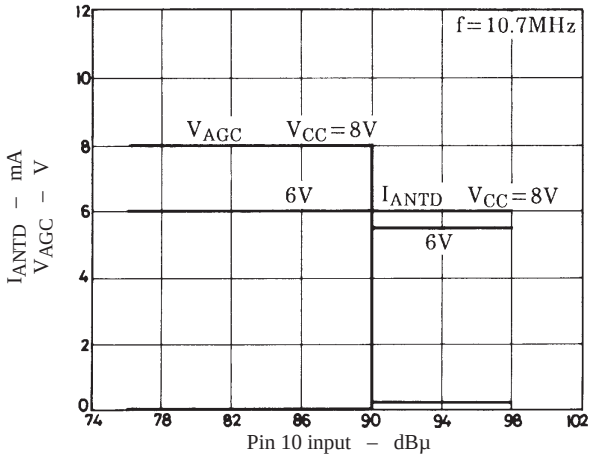

Unit (resistance : Ω, capacitance : F)

IF BLOCK Input/Output Characteristic

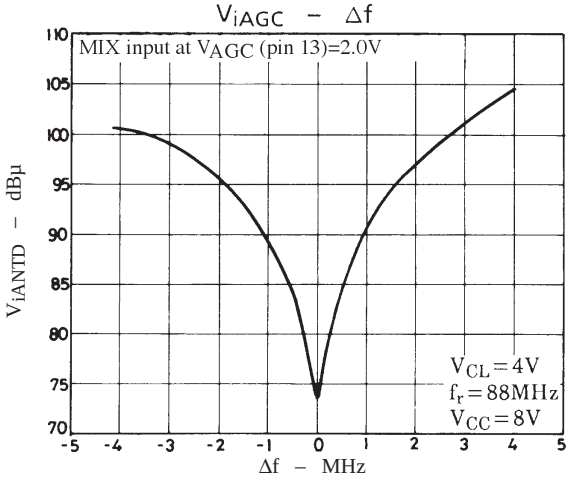


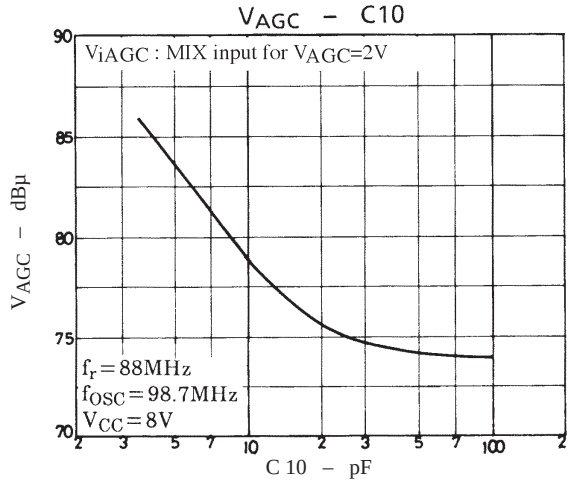

$V_{AGC}$ Input/Output Characteristic (AGC BLOCK)

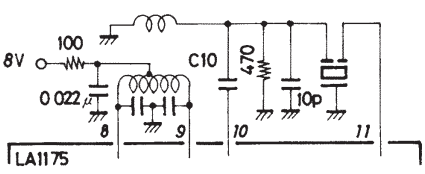



$V_{iAGC}$ – Δf

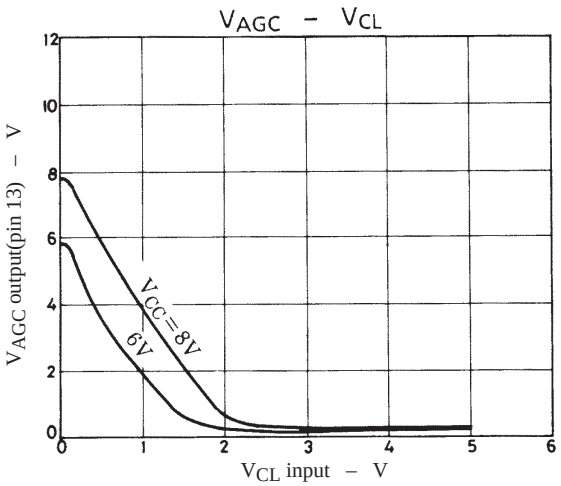


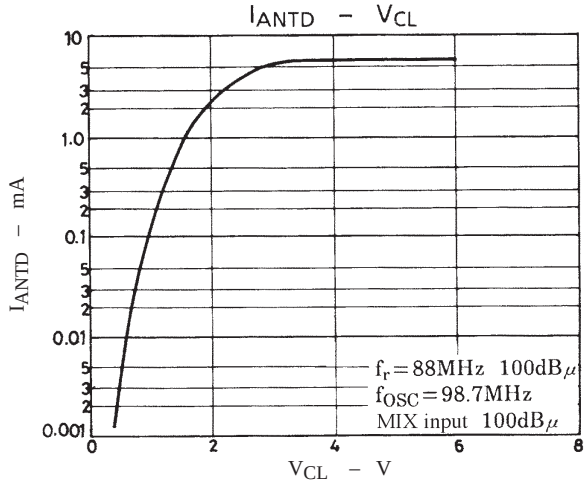

$V_{AGC}$ – C10

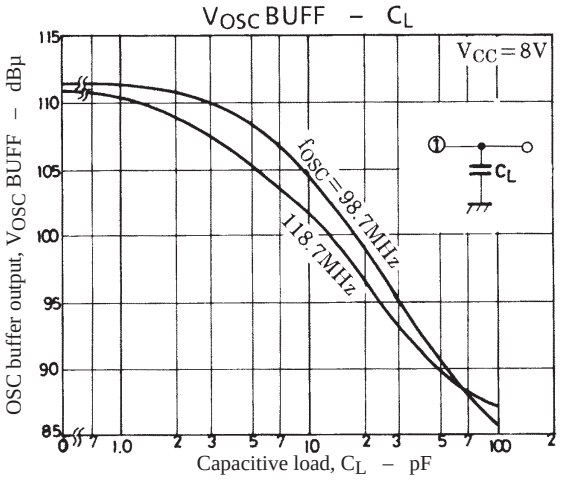


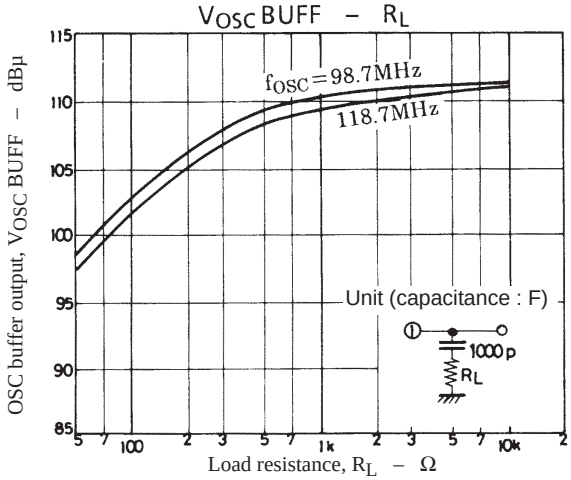



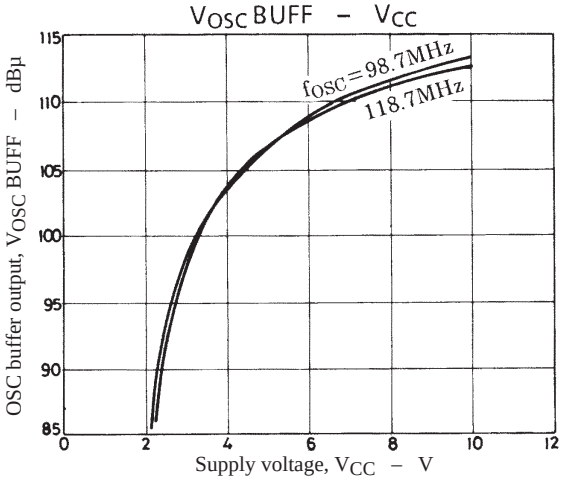

Unit (resistance : Ω, capacitance : F)

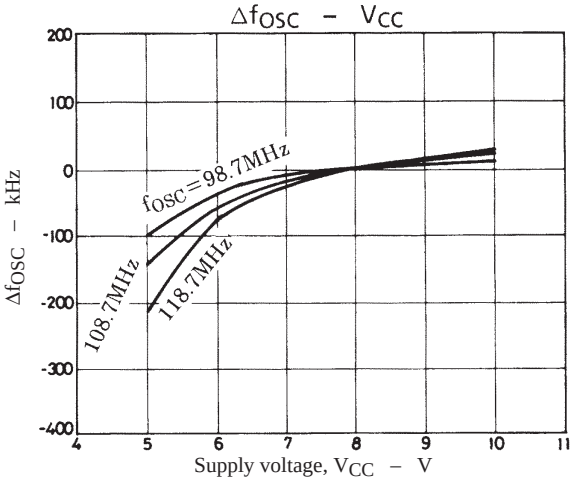

VAGC – VCL
VAGC output(pin 13) – V
VCC=8V
6V
VCL input – V

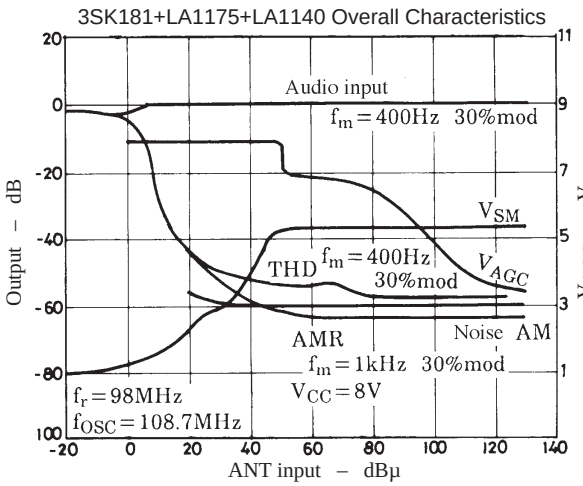

IANTD – VCL
IANTD – mA
fr=88MHz 100dBμ
fOSC=98.7MHz
MIX input 100dBμ
VCL – V

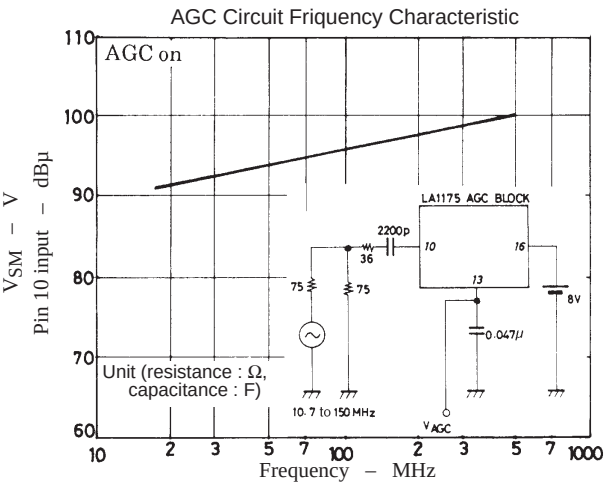

VOSC BUFF – CL
VCC=8V
fOSC=98.7MHz
118.7MHz
CL
OSC buffer output, VOSC BUFF – dBμ
Capacitive load, CL – pF

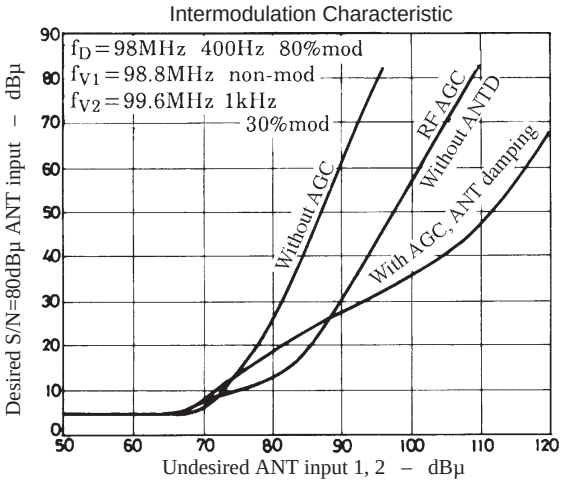

VOSC BUFF – RL
fOSC=98.7MHz
118.7MHz
Unit (capacitance : F)
1000p
RL
OSC buffer output, VOSC BUFF – dBμ
Load resistance, RL – Ω

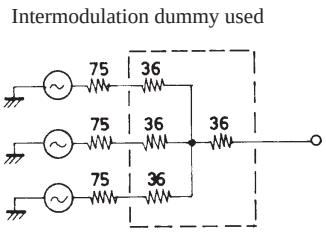

VOSC BUFF – VCC
fOSC=98.7MHz
118.7MHz
OSC buffer output, VOSC BUFF – dBμ
Supply voltage, VCC – V


ΔfOSC – VCC
fOSC=98.7MHz
108.7MHz
118.7MHz
ΔfOSC – kHz
Supply voltage, VCC – V

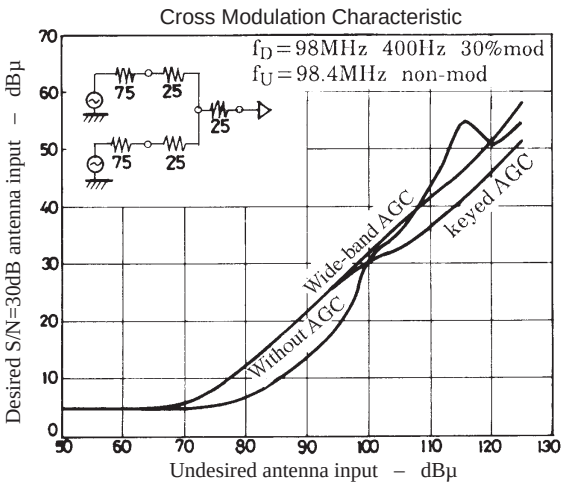

3SK181+LA1175+LA1140 Overall Characteristics
Audio input
fm=400Hz 30%mod
VSM
THD fm=400Hz 30%mod
VAGC
AMR
Noise AM
fm=1kHz 30%mod
fr=98MHz
fOSC=108.7MHz
VCC=8V
Output – dB
VAGC – V
VSM – V
ANT input – dBμ

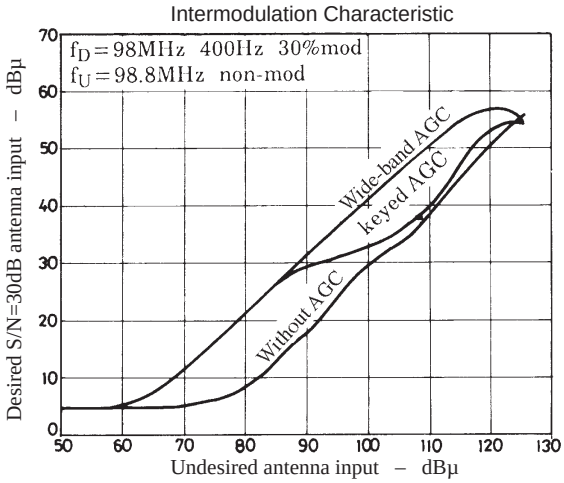

AGC Circuit Friquency Characteristic
AGC on
LA1175 AGC BLOCK
2200p
75
75
8V
0.047μ
Unit (resistance : Ω,
capacitance : F)
10.7 to 150MHz
VAGC
Pin 10 input – dBμ
Frequency – MHz




Unit (resistance : Ω)



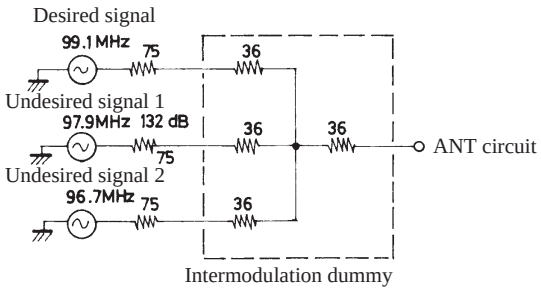

Improvement of IM characteristic in strong undesired input signal mode when ANT damping AGC is used (LA1174).

Test conditions

$f_D$ : 99.1MHz, $f_m$=400Hz 100% mod

$f_{U1}$ : 97.9MHz non-mod SG open 132dBμ

$f_{U2}$ : 96.7MHz $f_m$=1kHz 100% mod




Unit (resistance : Ω)

## Cross point

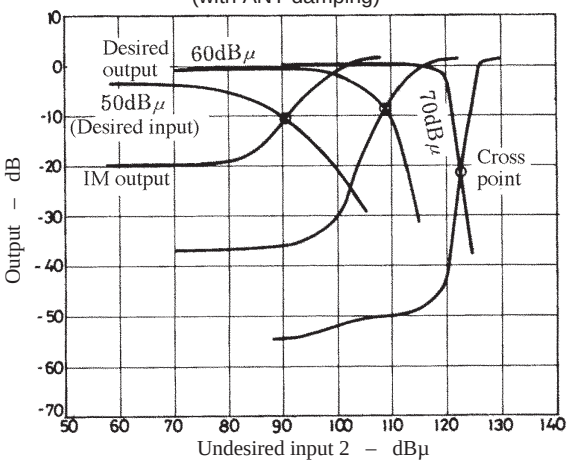
The open input level of undesired signal 2 at which the IM output and desired signal output are at the same level.

IM output
- Desired signal : Non-mod at each specified input
- Undesired signal 1 : Non-mod at input 132dBμ (SG open)
- Undesired signal 2 : 100% mod with input variable

Desired signal output
- Desired signal : 100% at each specified input
- Undesired signal 1 : Non-mod at input 132dBμ (SG open)
- Undesired signal 2 : Non-mod with input variable

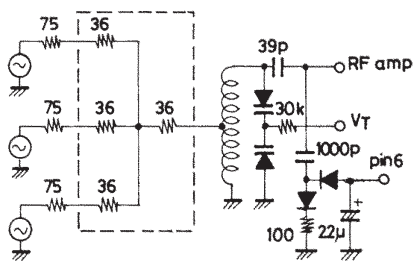
| Desired input level | | 50dBμ | 60dBμ | 70dBμ | 80dBμ | |
|---|---|---|---|---|---|---|
| Cross point | With ANT damping RF AGC and ANTD AGC | 90.5dBμ | 109dBμ | 123dBμ | Test impossible | Refer to Fig. A. |
| | Without ANT damping RF AGC only | 59.5dBμ | 72dBμ | 89dBμ | 98dBμ | Refer to Fig. B. |
| Improvement | | 31dB | 37dB | 34dB | | |

Fig. A Intermodulation Characteristic (with ANT damping)



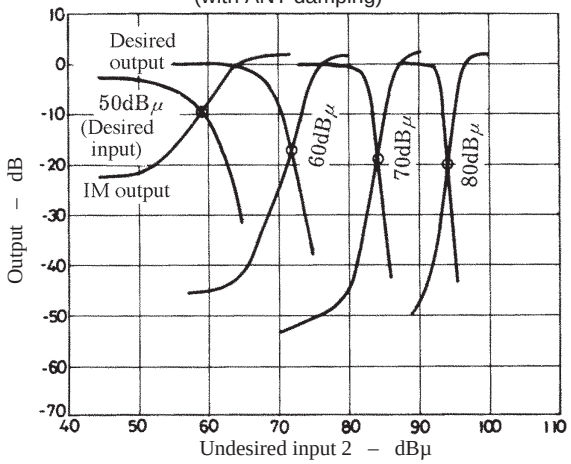

Solid line $f_D = 99.1MHz$ $f_m = 400Hz$ 700% mod
$f_{U1} = 97.9MHz$ non-nod
132dBμ (SG open)
$f_{U2} = 96.7MHz$ non-mod

Broken line $f_D = 99.1MHz$ non-mod
$f_{U1} = 97.9MHz$ non-mod
132dBμ (SG open)
$f_{U2} = 96.7MHz$ 1kHz 100% mod



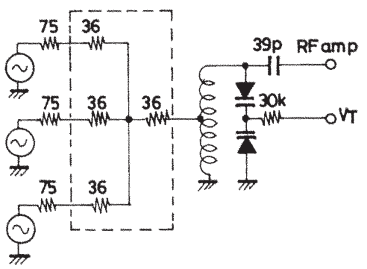

Intermodulation dummy

Fig. B Intermodulation Characteristic (with ANT damping)




Solid line $f_D = 99.1MHz$ $f_m = 400Hz$ 700% mod
$f_{U1} = 97.9MHz$ non-nod
132dBμ (SG open)
$f_{U2} = 96.7MHz$ non-mod

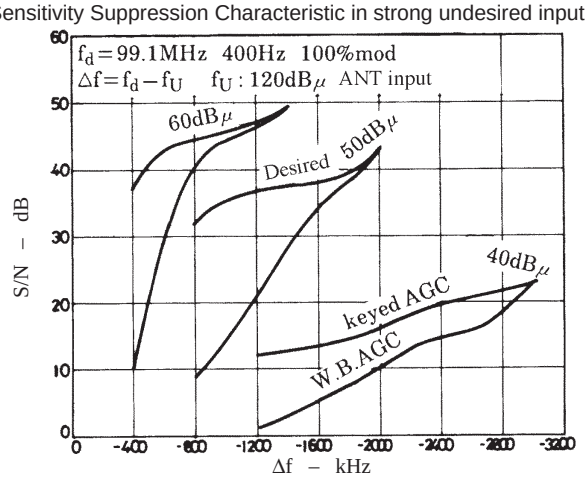
Broken line $f_D = 99.1MHz$ non-mod
$f_{U1} = 97.9MHz$ non-mod
132dBμ (SG open)
$f_{U2} = 96.7MHz$ 1kHz 100% mod

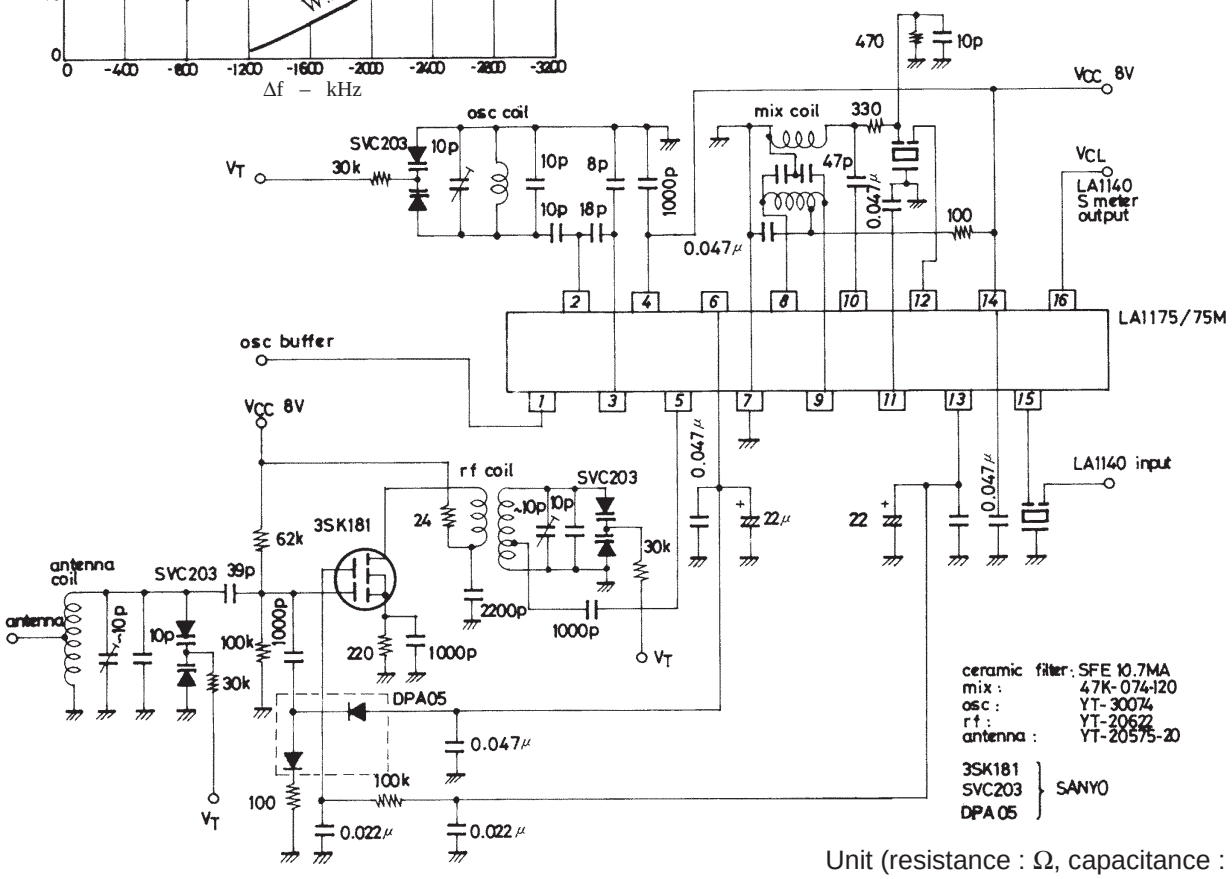



Intermodulation dummy

Unit (resistance : Ω, capacitance F)

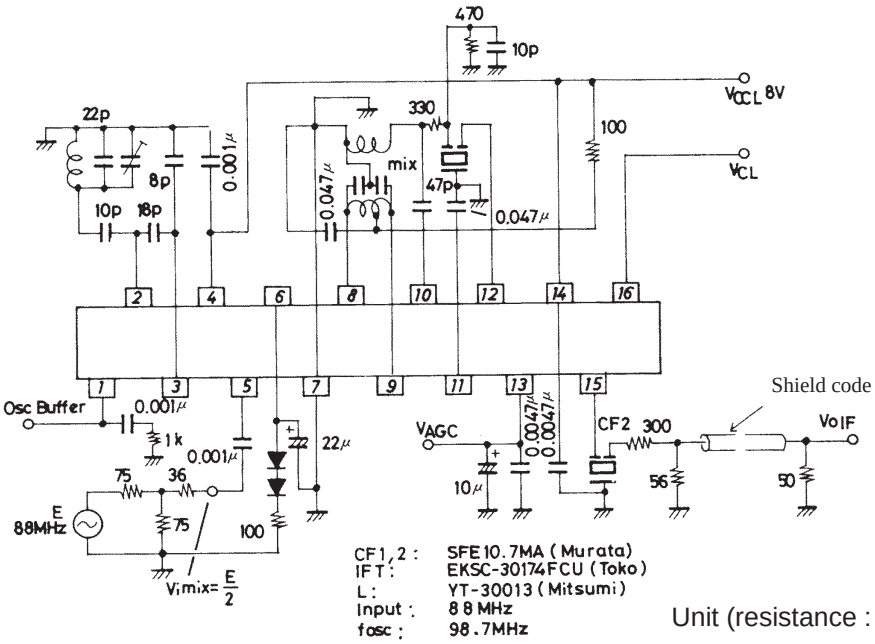
3SK181+LA1175+LA1140 Cross Modulation Characteristic
(Sensitivity Suppression Characteristic in strong undesired input signal mode



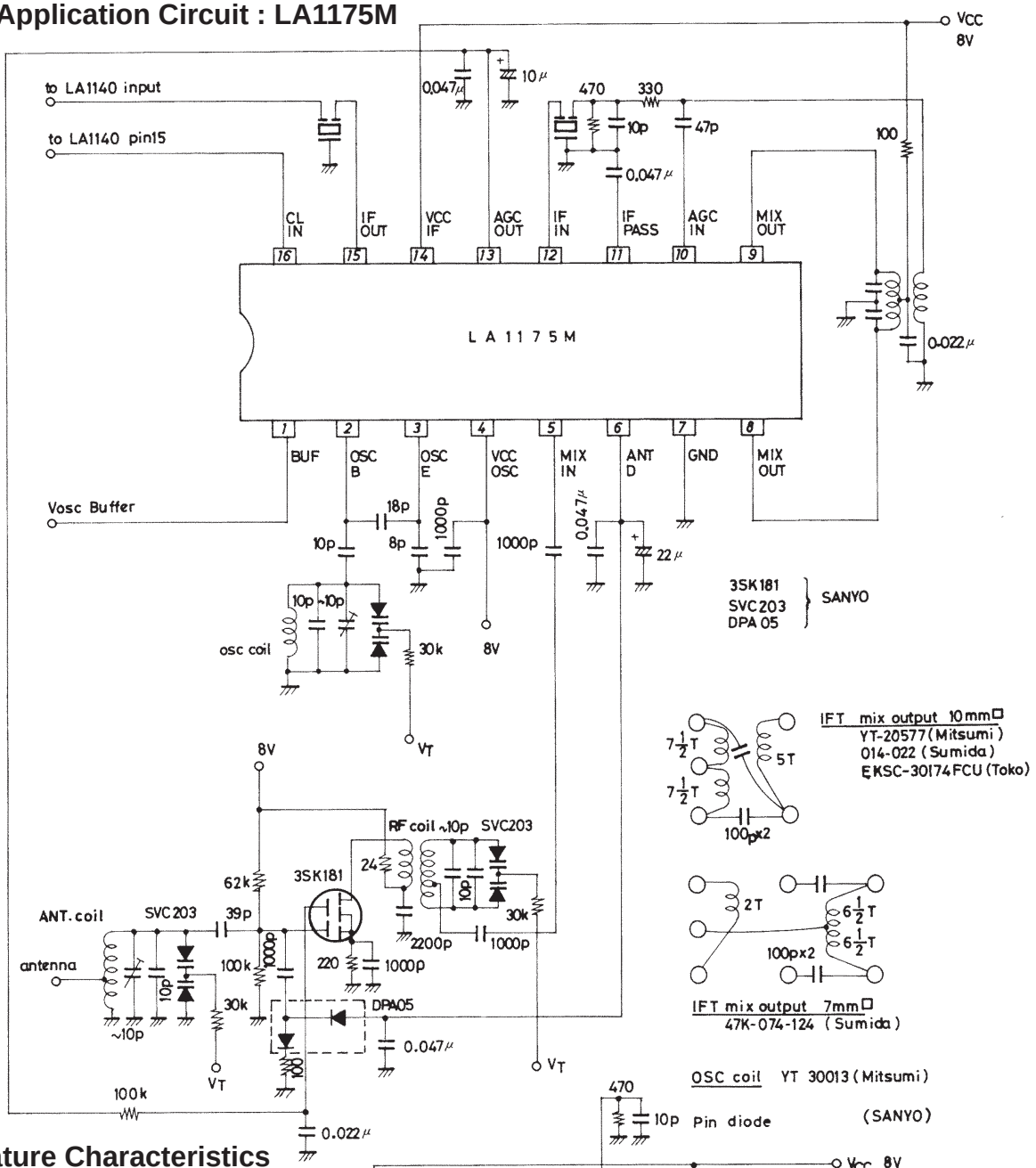

Unit (resistance : Ω, capacitance : F)

## Test Circuit




Unit (resistance : Ω, capacitance : F)

## Sample Application Circuit : LA1175M



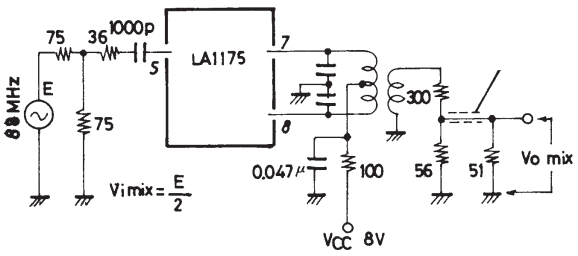

## Temperature Characteristics

**(1), (2), (3)**

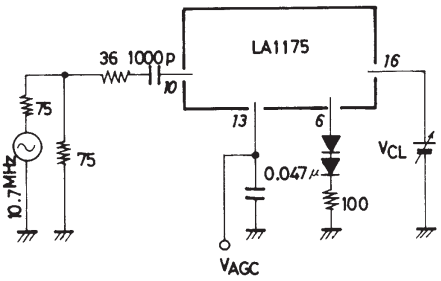
Test Circuit

Unit (resistance : Ω, capacitance : F)

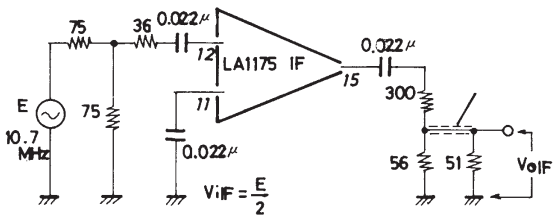
## Temperature Characteristics (4)



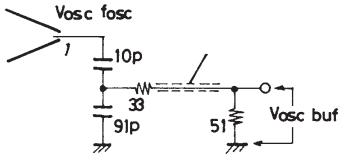

## Temperature Characteristics (5)




## Temperature Characteristics (6)

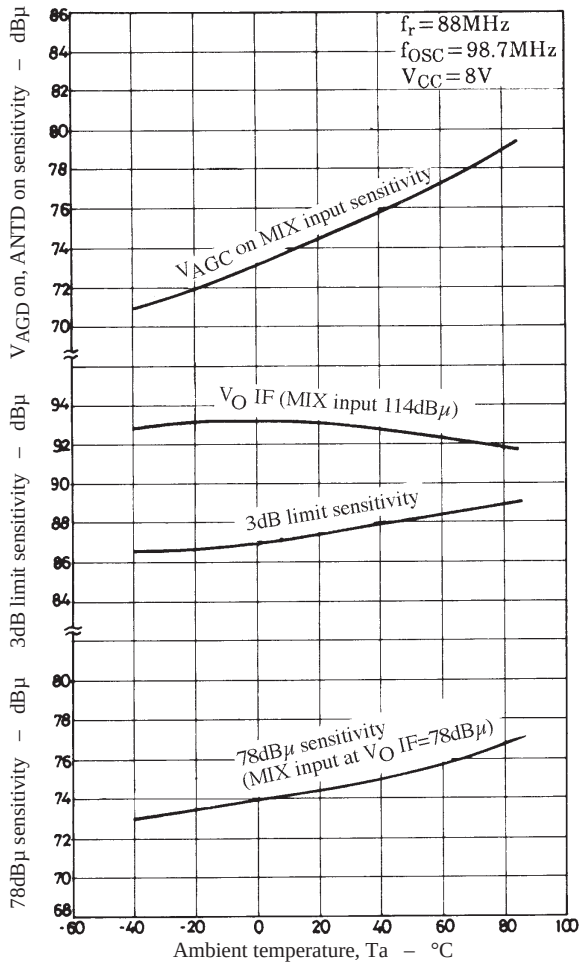



## Temperature Characteristics (7)

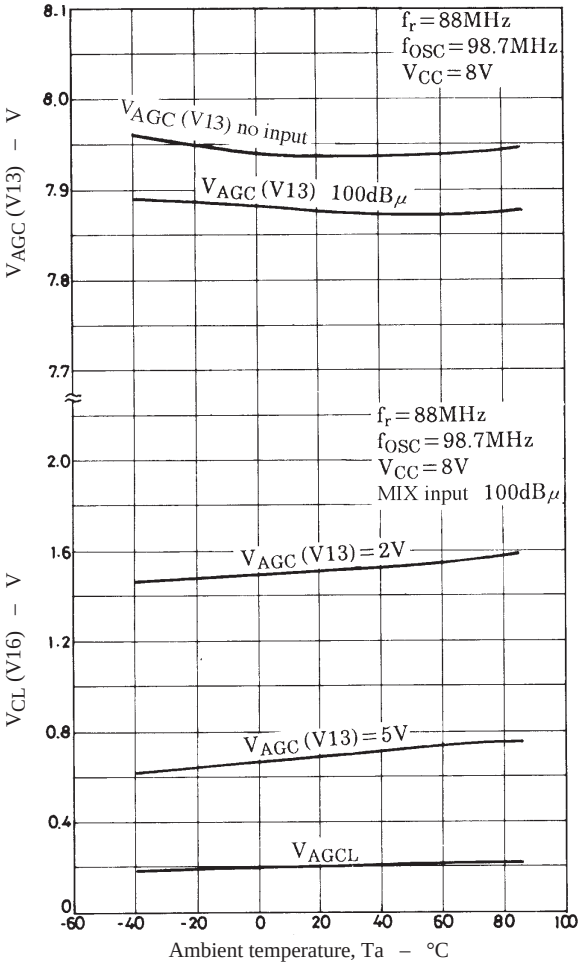



Unit (resistance : Ω, capacitance : F)

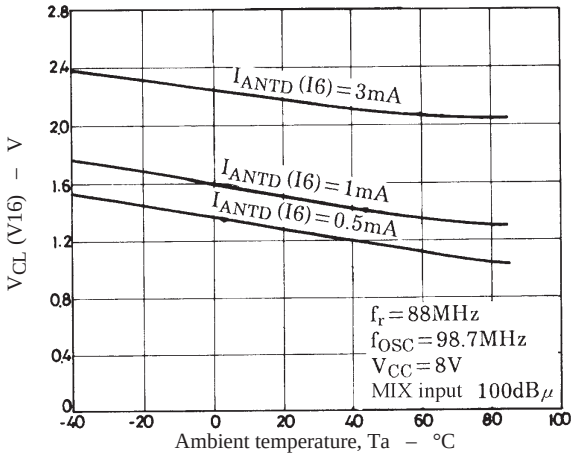
Temperature Characteristic (1)



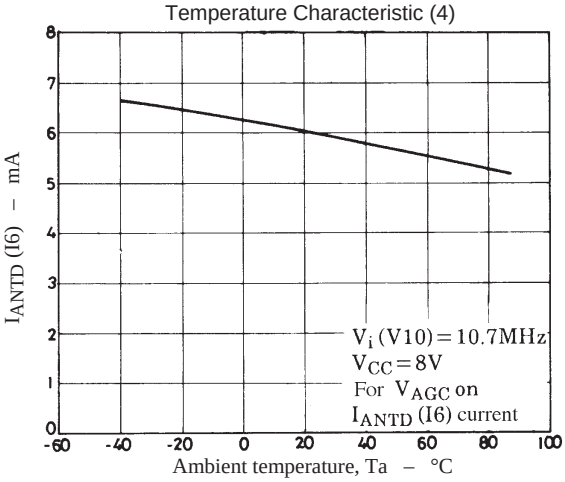

Temperature Characteristic (2)



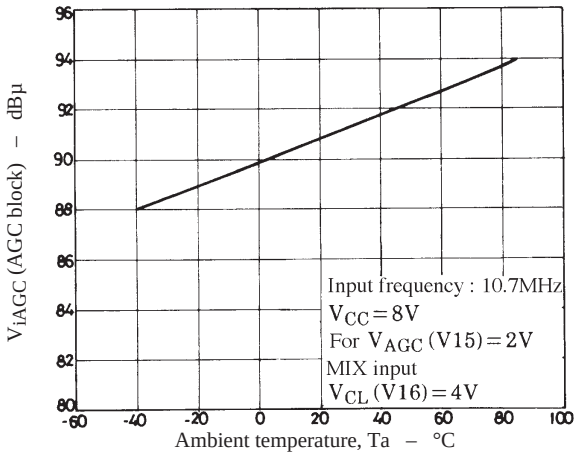
Temperature Characteristic (3)




Temperature Characteristic (4)




Temperature Characteristic (4)

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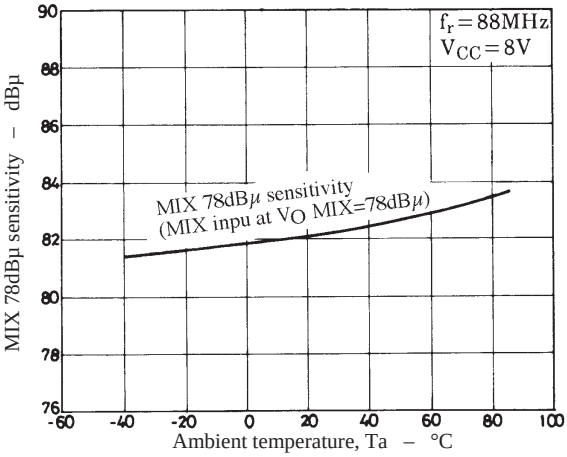


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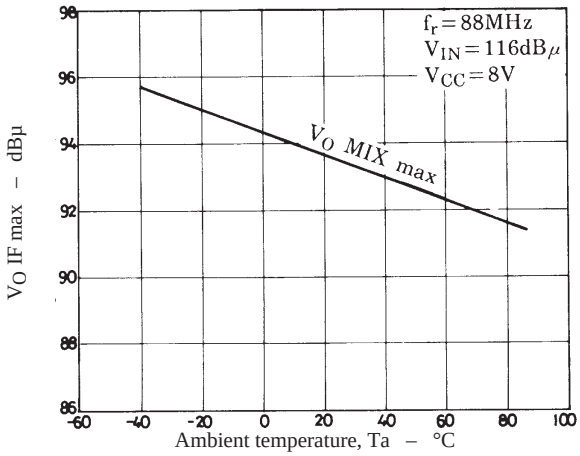


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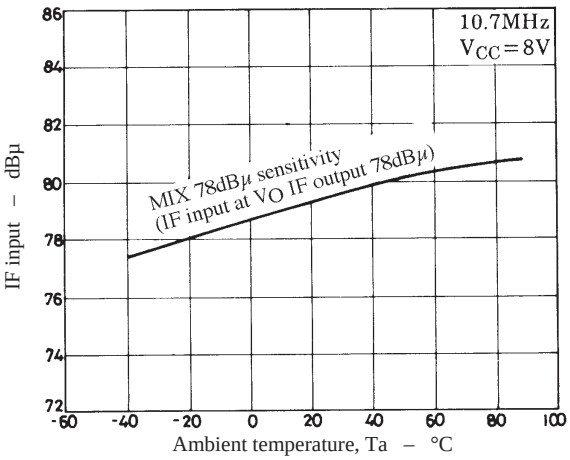


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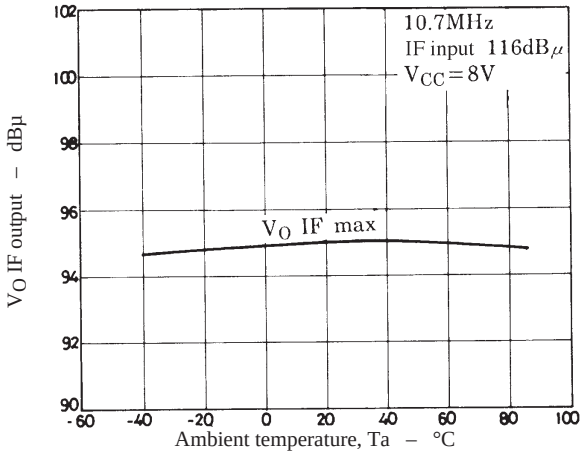
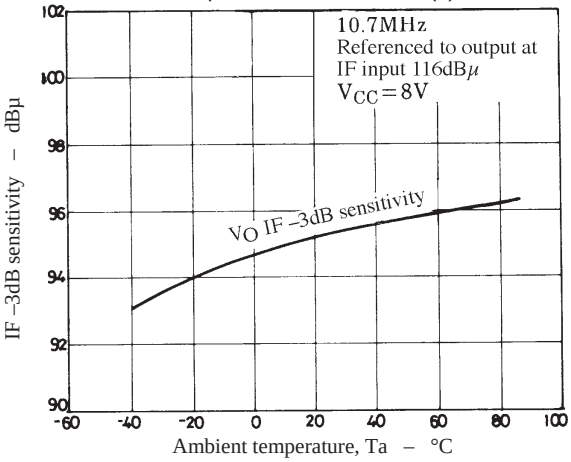
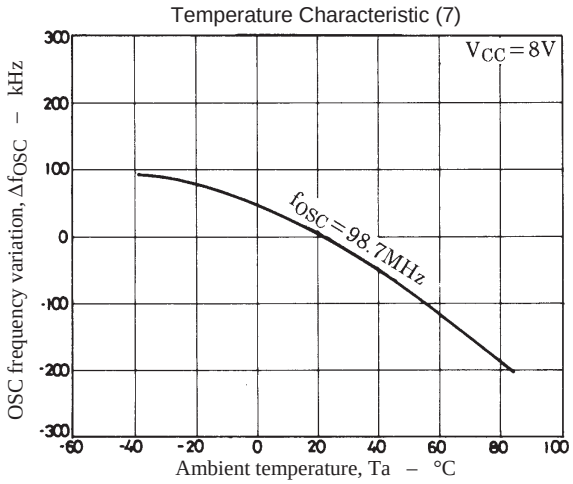
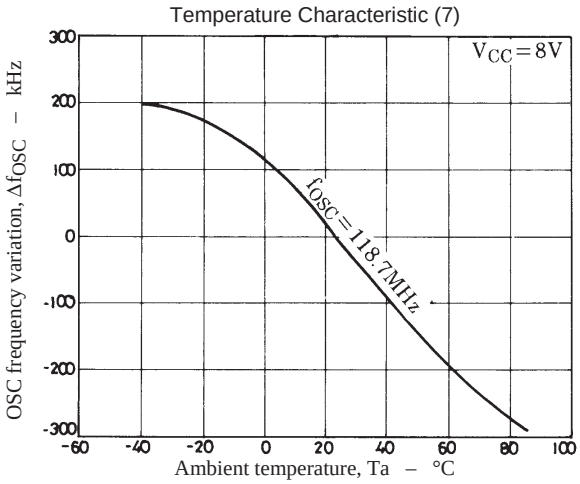
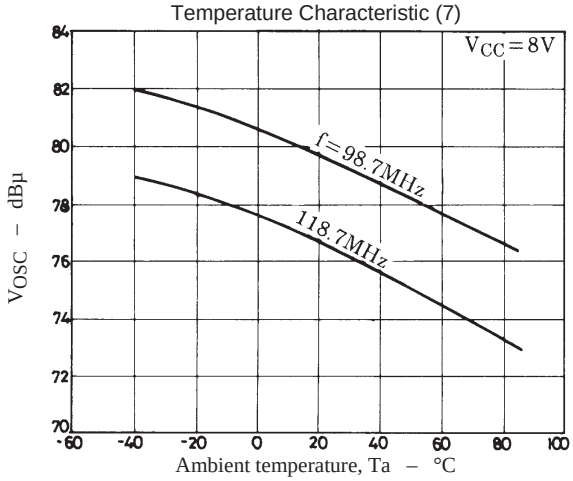



Temperature Characteristic (6)






## Description of AGC circuit in the LA1175, 1175M

The LA1175, 1175M are designed so that AGC is operated in the order shown below.

ANT damping (PIN diode) → MOS FET 2nd gate voltage control

(Attenuation)20dB (Attenuation)60dB

The following are the reasons why AGC is operated in this order.

(1) When a signal of 110dBμ or greater is applied to the varactor in the ANT circuit, intermodulation may occur. In this case, if AGC is operated in the order of MOS FET 2nd gate control AGC → ANT damping (PIN diode), the input to the varactor in the ANT circuit is not restricted unless a strong signal with AGC attenuation 60dB or greater is given. Therefore, AGC should be operated in the order shown above.

(2) If the two AGC loops (AGC loop (ANT damping) and AGC loop (MOS FET 2nd gate control)) are operated simultaneously, the transient response of AGC loses stability. Therefore, the order shown below is impracticable.

MOS FET 2nd gate control → ANT damping → MOS FET 2nd gate control.

## Relation between keyed AGC and two AGC loops

For the LA1170, keyed AGC provides AGC attenuation control (RF MOS FET 2nd gate). For the LA1175, 1175M, however, there are two AGC loops as shown above. Therefore, keyed AGC must be applied to both of the two AGC loops. The LA1175, 1175M contain the ANT damping circuit to improve intermodulation in a strong field, but the prevention of intermodulation in a strong field and the improvement of the sensitivity suppression characteristic by keyed AGC are mutually exclusive as mentioned below.

| | | |
|---|---|---|
| Conditions | Desired signal | Weak field |
| | Undesired signals 1, 2 | Strong field (Field strength in which the ANT circuit may cause intermodulation to occur) |

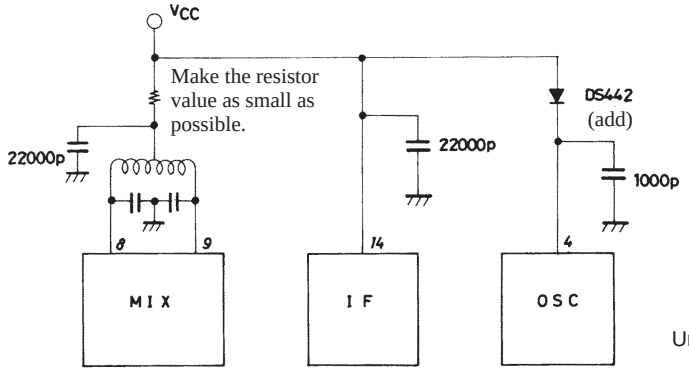
If keyed AGC is operated to cause AGC-OFF mode to be entered when a desired signal is received, the varactor in the ANT circuit may be distorted and intermodulation may occur, which means that it is meaningless for the LA1175, 1175M to contain the ANT damping circuit because it produces no effect. Therefore, the effect of the keyed AGC circuit in the LA1175, 1175M on the ANT damping circuit is made less than that in the LA1170 so that the above-mentioned problem does not arise. However, if the LA1175, 1175M are used under the same conditions as for the LA1170 (no ANT damping, pin 6 open), keyed AGC is operated in the same manner as for the LA1170.

## Application circuit used in a very strong field

Since the LA1175, 1175M are designed to be operated from single supply, the dynamic range of the MIX output becomes narrower as compared with the dual-supply type ($V_{CC}$ MIX=12V, other=8V) heretofore in use. IF an adjacent interference channel signal is very strong, the intermodulation characteristic at Δf=400kHz is deteriorated, because the dynamic range of the MIX output exceeds the limit, which causes a distortion to occur.

The following three countermeasures are available.

1. Q of the MIX coil is made higher to provide a higher selectivity.
   (Must be balanced with the detection band of the wide-band AGC)
2. The LA1175, 1175M are operated from dual supplies (Most ideal).
3. The application circuit shown below is used.




Unit (capacitance : F)