NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC2798GR

IF DOWN CONVERTOR IC FOR DIGITAL CATV

DESCRIPTION

The μPC2798GR is a Silicon monolithic IC designed for use as QAM IF down convertor for digital CATV. This IC consists of AGC amplifier, mixer, oscillator, and video amplifier.

The package is 20 pins SSOP suitable for high-density surface mount.

FEATURES

- Low distortion AGC amplifier — $IIP_3 = -9$ dBm
- On chip IF convertor — fin = 30 to 250 MHz
- On chip video amplifier — Vout = 3.0 V_{P-P} (differential, @ R_L = 1kΩ)
- Supply voltage: 5 V
- Packaged in 20 pins SSOP suitable for high-density surface mount.

ORDERING INFORMATION

PART NUMBER	PACKAGE	PACKAGE STYLE
μPC2798GR-E1	20 pins plastic SSOP (225 mil)	Embossed tape 12 mm wide. 2.5 k/REEL. Pin 1 indicates pull-out direction of tape

*: For evaluation sample order, please contact your local NEC office.
(Part number for sample order: μPC2798GR)

Please refer to "Quality grade on NEC Semiconductor Devices" (Document number C11531E) published by NEC Corporation to know the specification of quality grade on the devices and its recommended applications.

Caution electro-static sensitive device

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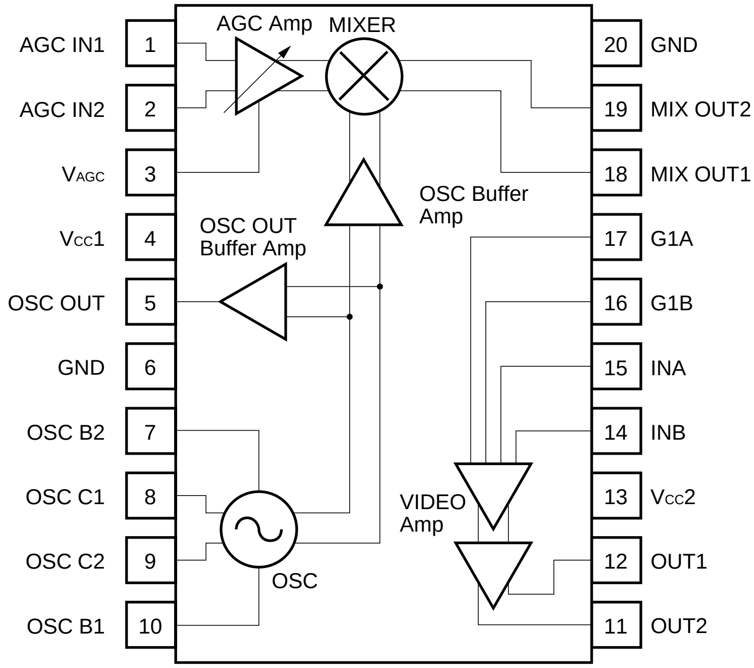
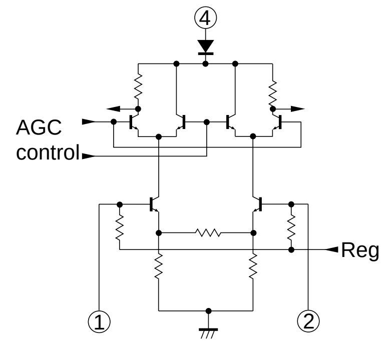
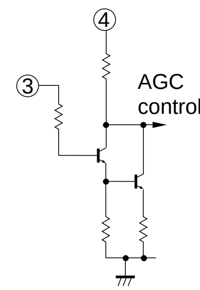
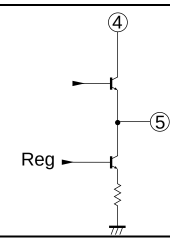
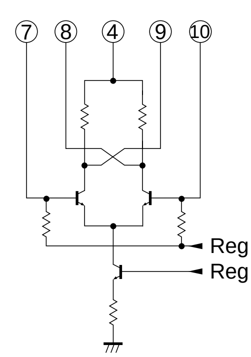
The mark ★ shows major revised points.

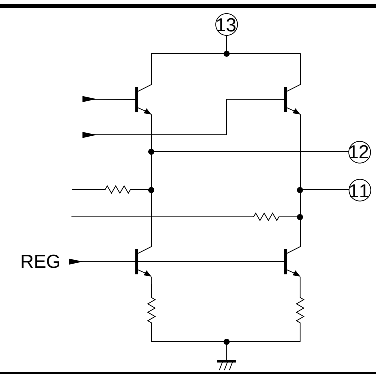
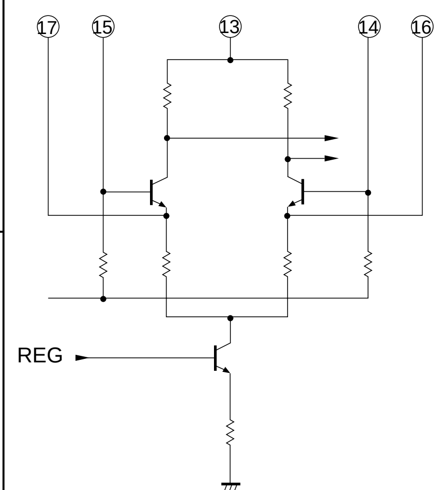
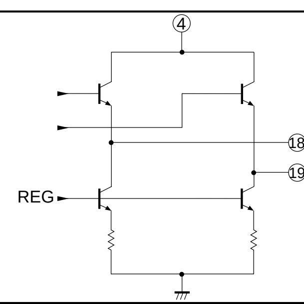
INTERNAL BLOCK DIAGRAM AND PIN CONFIGURATION (Top View)



PIN EXPLANATIONS

Pin No.	Symbol	Pin Voltage (V, TYP.)	Explanation	Equivalent Circuit
1	AGC IN1	1.5	Input pin of IF signal. 1pin is same phase and 2pin is opposite phase at balance input. In case of single input, 1pin or 2pin should be grounded through capacitor.	
2	AGC IN2	1.5		
3	V_{AGC}	0 to 5	Automatic gain control pin. This pin's bias govern the AGC output level. Minimum gain at V_{AGC} = 0 V Maximum gain at V_{AGC} = 5 V Recommend to use by deviding AGC voltage with externally resistor (ex. 100 kΩ).	
4	Vcc1	5.0	Power supply pin of IF down convertor block. Must be connected bypass capacitor to minimize ground impedance.	
5	OSC OUT	4.0	Output pin of Oscillator frequency. Connected to PLL symthesizer IC's input pin.	
6	GND	0.0	Ground pin. Must be connected to the system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.	
7	OSC B2	2.4	Internal oscillator consist in balance amplifier. 7 and 8pins, 9 and 10 pins should be externally connected to oscillate with active feedback loop. Connected LC resonator between 7pin and 10pin.	
8	OSC C1	4.6		
9	OSC C2	4.6		
10	OSC B1	2.4		

PIN EXPLANATIONS

Pin No.	Symbol	Pin Voltage (V, TYP.) ( ) is value at Vcc2 = 9 V.	Explanation	Equivalent Circuit
11	OUT2	2.5 (4.7)	Output pin of video amplifier. In case of R_L = 1 kΩ, differential output voltage equal 3 V_{P-P}. OUT1 and INA are same phase. OUT2 and INB are same phase.	
11	OUT1	2.5 (4.7)		
13	Vcc2	5 to 9	Power supply pin of video amplifier. Must be connected bypass capacitor to minimize ground impedance.	
14	INB	2.5 (4.1)	Signal input pin of video amplifier. This pin is high impedance.	
15	INA	2.5 (4.1)		
16	G1B	1.7 (3.3)	Gain control pin of video amplifier. Maximum gain at G1A-GIB = short. Minimum gain at G1A-G1B = open. Gain is able to adjust by inserting arbitrary resistor between 16pin and 17pin.	
17	G1A	1.7 (3.3)		
18	MIX OUT1	3.7	Output pin of mixer. This output pin features low-impedance because of its emitter-follower output port.	
19	MIX OUT2	3.7		
20	GND	0.0	Ground pin. Must be connected to the system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.	

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C unless otherwise specified)

PARAMETER	SYMBOL	RATING	UNIT	TEST CONDITIONS
Supply Voltage 1	Vcc1	6.0	V	Mixer block
Supply Voltage 2	Vcc2	6.0	V	Video Amp block
Power Dissipation	P_D	430	mW	T_A = 85 °C*1
Operating Ambient Temperature	T_A	–40 to +85	°C	
Storage Temperature	T_{stg}	–55 to +150	°C	

PARAMETER	SYMBOL	RATING	UNIT	TEST CONDITIONS
Supply Voltage 1	Vcc1	6.0	V	Mixer block
Supply Voltage 2	Vcc2	11.0	V	Video Amp block
Power Dissipation	P_D	500	mW	T_A = 75 °C*1
Operating Ambient Temperature	T_A	–40 to +75	°C	
Storage Temperature	T_{stg}	–55 to +150	°C	

***1.** Mounted on 50 × 50 × 1.6 mm double copper epoxy glass board.

RECOMMENDED OPERATING RANGE

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage 1	Vcc1	4.5	5.0	5.5	V
Supply Voltage 2	Vcc2	4.5	5.0	10.0	V
Operating Ambient Temperature 1*2	T_A1	–40	+25	+85	°C
Operating Ambient Temperature 2*3	T_A2	–40	+25	+75	°C

***2.** @Vcc1 = Vcc2 = 4.5 to 5.5 V

***3.** @Vcc1 = 4.5 to 5.5 V, Vcc2 = 4.5 to 10.0 V

ELECTRICAL CHARACTERISTICS (T_A = 25 °C)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Total Block (R_L = 1 kΩ, by measurement circuit 5)						
Circuit Current 1	Icc1	24.0	35.5	45.0	mA	no input signal, Vcc1 = Vcc2 = 5 V
Maximum Conversion Gain 1	$CG_{MAX}1$	68.0	74.0	76.0	dB	V_{AGC} = 4.0 V, G1A-G1B pins: short*4
Maximum Conversion Gain 2	$CG_{MAX}2$	—	58.0	—	dB	V_{AGC} = 4.0 V, G1A-G1B pins: open*4
Minimum Conversion Gain 1	$CG_{MIN}1$	32.0	39.0	43.0	dB	V_{AGC} = 1.0 V, G1A-G1B pins: short*4
Minimum Conversion Gain 2	$CG_{MIN}2$	—	22.0	—	dB	V_{AGC} = 1.0 V, G1A-G1B pins: open*4
Circuit Current 2	Icc1	32.0	47.0	60.0	mA	no input signal, Vcc1 = 5 V, Vcc2 = 9 V
Maximum Conversion Gain 3	$CG_{MAX}3$	72.0	78.5	81.0	dB	V_{AGC} = 4.0 V, G1A-G1B pins: short*4
Maximum Conversion Gain 4	$CG_{MAX}4$	—	59.0	—	dB	V_{AGC} = 4.0 V, G1A-G1B pins: open*4
Minimum Conversion Gain 3	$CG_{MIN}3$	—	43.5	—	dB	V_{AGC} = 1.0 V, G1A-G1B pins: short*4
Minimum Conversion Gain 4	$CG_{MIN}4$	—	22.5	—	dB	V_{AGC} = 1.0 V, G1A-G1B pins: open*4

ELECTRICAL CHARACTERISTICS (T_A = 25 °C)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
AGC Amplifier + Mixer Block (@Vcc1 = 5 V, R_L = 50 Ω, by measurement circuit 1)						
Circuit Current 3	Icc3	15.0	23.0	28.0	mA	no input signal
RF Input Frequency Range	f_{RF}	30	—	250	Mhz	
OSC Frequency Range	f_{OSC}	30	—	250	Mhz	
IF Output Frequency Range	f_{IF}	DC	—	150	Mhz	
Minimum Conversion Gain 5	$CG_{MAX}5$	—	25	—	dB	V_{AGC} = 4.0 V *4
Minimum Conversion Gain 5	$CG_{MIN}5$	—	–7	—	dB	V_{AGC} = 1.0 V *4
AGC Dynamic Range	GCR	26	32	—	dB	V_{AGC} = 1.0 to 4.0 V
Noise Figure	NF	—	9	—	dB	SSB, V_{AGC} = 4.0 V (@Maximum Gain) *4, 5
AGC Voltage High Level	$V_{AGC}H$	4.0	—	—	V	@Maximum Gain
AGC Voltage Low Level	$V_{AGC}L$	—	—	1.0	V	@Minimum Gain
Video Amp. Block (@Vcc2 = 5 V, R_L = 1 kΩ, Input: 51 Ω terminated, by measurement circuit 3)						
Circuit Current 4	Icc4	9.0	12.5	17.0	mA	no input signal
Differential Gain 1	G1	—	200	—	V/V	G1A-G1B pins: short, Vout = 3.0 V_{P-P}, fin = 10 MHz
Differential Gain 2	G2	—	26.0	—	V/V	G1A-G1B pins: open, Vout = 3.0 V_{P-P}, fin = 10 MHz
Video Amp. Block (@Vcc2 = 9 V, R_L = 1 kΩ, Input: 51 Ω terminated, by measurement circuit 3)						
Circuit Current 5	Icc5	17.0	24.0	32.0	mA	no input signal
Differential Gain 3	G3	—	385	—	V/V	G1A-G1B pins: short, Vout = 3.0 V_{P-P}, fin = 10 MHz
Differential Gain 4	G4	—	28.5	—	V/V	G1A-G1B pins: open, Vout = 3.0 V_{P-P}, fin = 10 MHz
Video Amp. Block (@Vcc2 = 5 V or 9 V: Common, R_L = 1 kΩ, Input: 51 Ω terminated, by measurement circuit 3)						
Output Voltage	V_{OUT}	—	3.0	—	V_{P-P}	R_L = 1 kΩ, differential
Bandwidth 1	BW_{G1}	—	50	—	MHz	G1 (G1A-G1B pins: short)
Bandwidth 2	BW_{G2}	—	50	—	MHz	G2 (G1A-G1B pins: open)
Input Resistance 1	Rin1	—	3.5	—	kΩ	G1 (G1A-G1B pins: short)
Input Resistance 2	Rin2	—	9.7	—	kΩ	G2 (G1A-G1B pins: open)
Input Capacitance	Cin	—	1.6	—	pF	

***4**. f_{RF} = 45 MHz, f_{OSC} = 55 MHz, P_{OSC} = –10 dBm
***5**. By measurement circuit 2

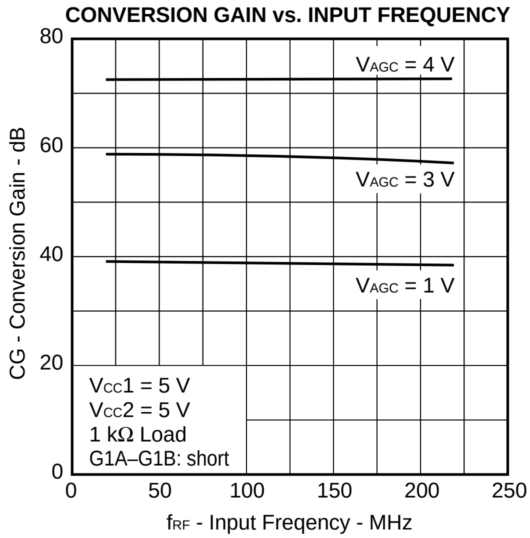
STANDARD CHARACTERISTICS (T_A = 25 °C)

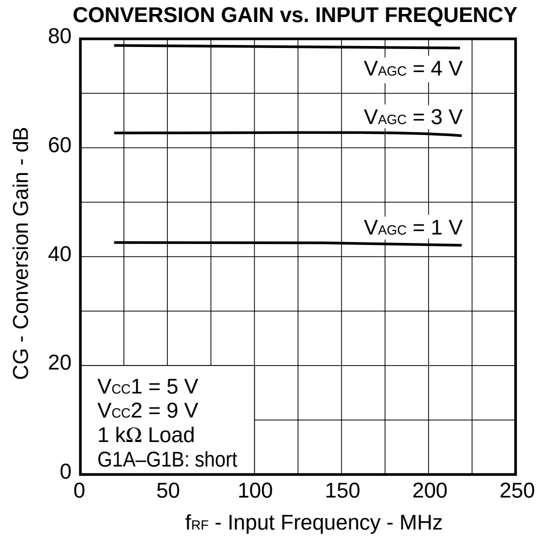
PARAMETER	SYMBOL	VALUE FOR REFERENCE	UNIT	TEST CONDITIONS
AGC Amplifier + Mixer Block (@Vcc1 = 5 V, by measurement circuit 1)				
AGC Input Intercept Point 1	AGC $IIP_3$1	–9	dBm	V_{AGC} = 1.0 V @Minimum Gain ***6**
Video Amp. Block (R_L = 50 Ω, input: 51 Ω terminated, by measurement circuit 4)				
Single-end Gain 1	A_{VS}1	40.0	dB	V_{CC}2 = 5 V, G1A-G1B pins: short
Single-end Gain 2	A_{VS}2	22.5	dB	V_{CC}2 = 5 V, G1A-G1B pins: open
Single-end Gain 3	A_{VS}3	45.0	dB	V_{CC}2 = 9 V, G1A-G1B pins: short
Single-end Gain 4	A_{VS}4	23.5	dB	V_{CC}2 = 9 V, G1A-G1B pins: open
Input Intercept Point 2	$IIP_3$2	–11.5	dBm	V_{CC}2 = 5 V, G1A-G1B pins: open fin1 = 9 MHz, fin2 = 11 MHz
Input Intercept Point 3	$IIP_3$3	–5.0	dBm	V_{CC}2 = 9 V, G1A-G1B pins: open fin1 = 9 MHz, fin2 = 11 MHz
Video Amp. Block (@Vcc2 = 5 V or 9 V: Common, by measurement circuit 3)				
Common Mode Rejection Ratio	CMRR	80	dB	V_{CM} = 1 V_{P-P}, f = 100 kHz
Power Supply Rejection Ratio	PSRR	70	dB	
Rise Time	τ_R	2.6	ns	
Propagation Delay Time	τ_{PD}	4.4	ns	
Total Block (R_L = 1 kΩ, by measurement circuit 5)				
Input Intercept Point 4	$IIP_3$4	–14.0	dBm	V_{CC}1 = V_{CC}2 = 5 V, V_{AGC} = 1 V, G1A-G1B pins: short ***6**
Input Intercept Point 5	$IIP_3$5	–8.0	dBm	V_{CC}1 = V_{CC}2 = 5 V, V_{AGC} = 1 V, G1A-G1B pins: open ***6**
Input Intercept Point 6	$IIP_3$6	–7.5	dBm	V_{CC}1 = 5 V, V_{CC}2 = 9 V, V_{AGC} = 1 V, G1A-G1B pins: open ***6**

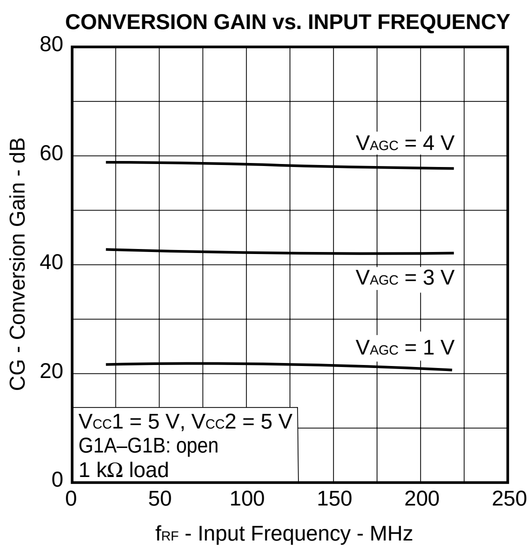
***6** f_{RF}1 = 44 MHz, f_{RF}2 = 46 MHz, f_{OSC} = 55 MHz, P_{OSC} = –10 dBm

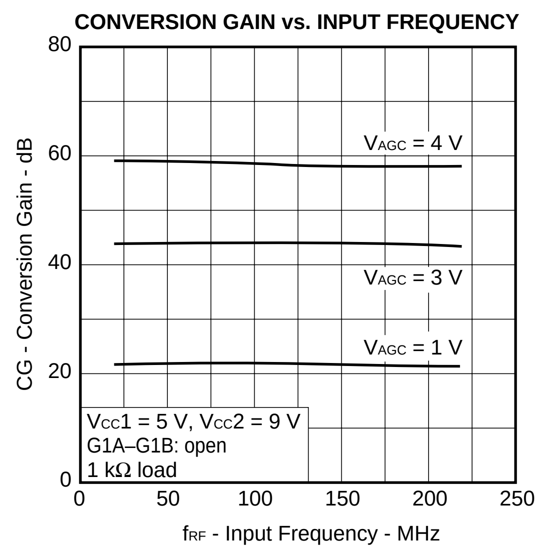
TYPICAL CHARACTERISTICS

(by measurement circuit 5, T_A = 25 °C, f_{OSC} = f_{RF} + 10 MHz, P_{OSC} = –10 dBm)





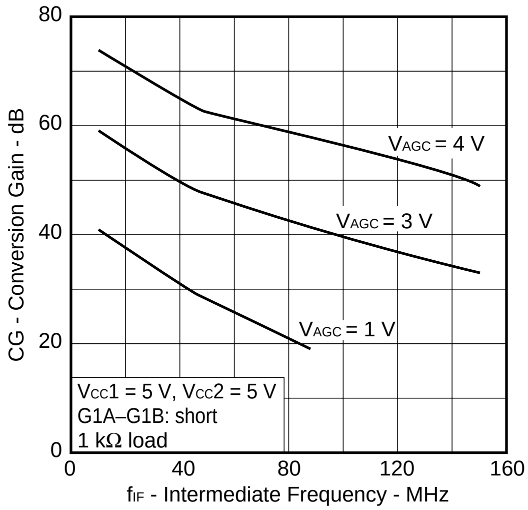




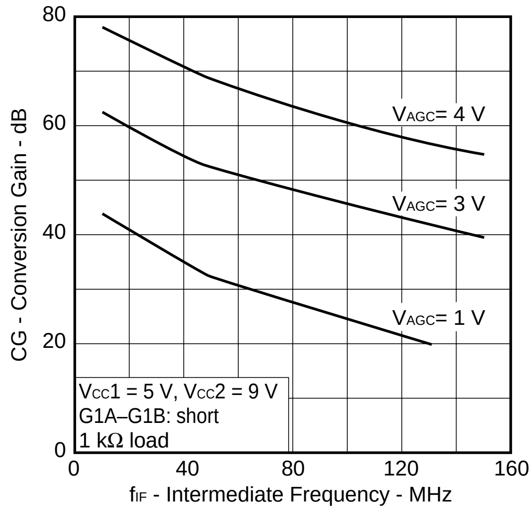
TYPICAL CHARACTERISTICS

(by measurement circuit 5, T_A = 25 °C, f_{RF} = 45 MHz, P_{OSC} = –10 dBm)

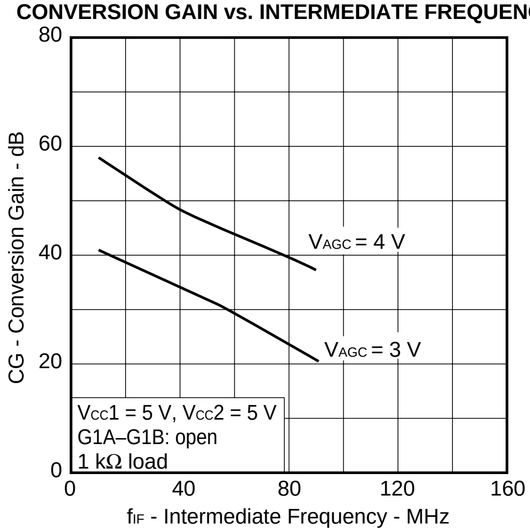
CONVERSION GAIN vs. INTERMEDIATE FREQUENCY



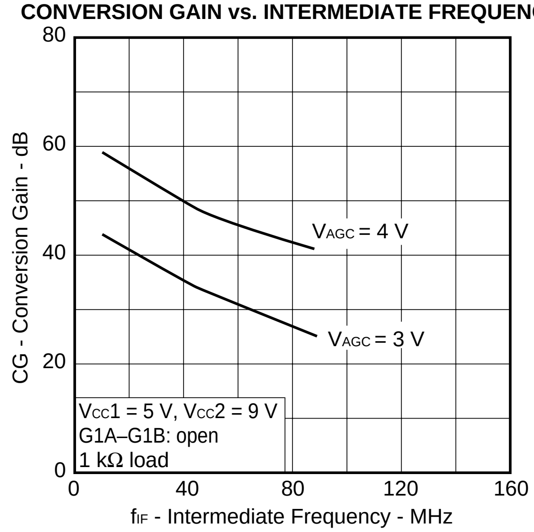
CONVERSION GAIN vs. INTERMEDIATE FREQUENCY



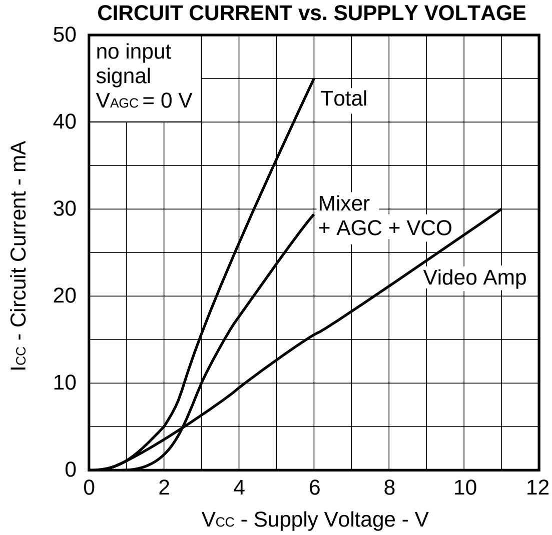
CONVERSION GAIN vs. INTERMEDIATE FREQUENCY

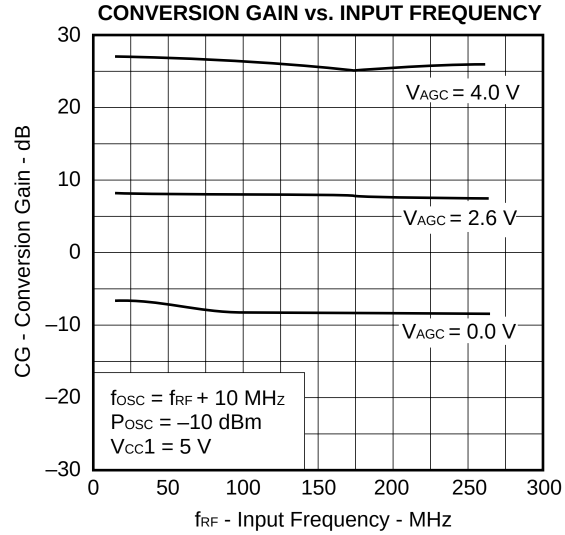


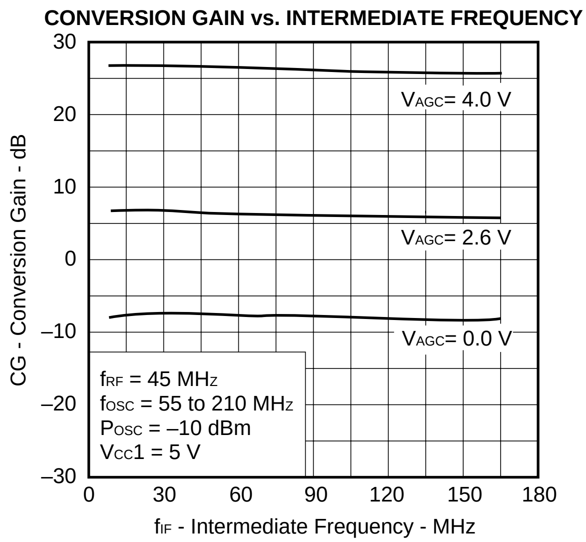
CONVERSION GAIN vs. INTERMEDIATE FREQUENCY

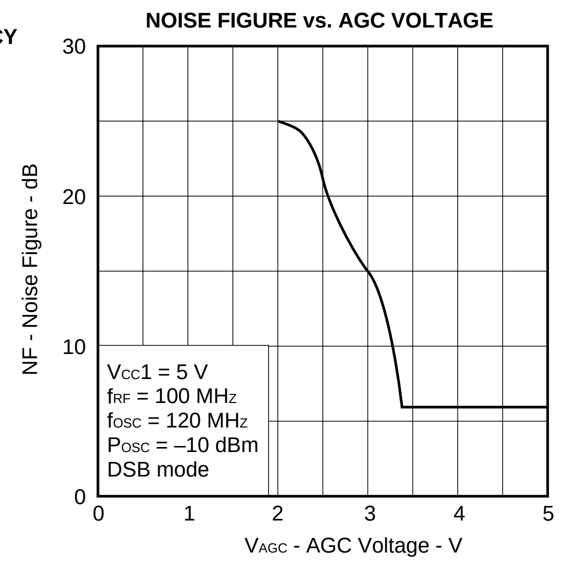


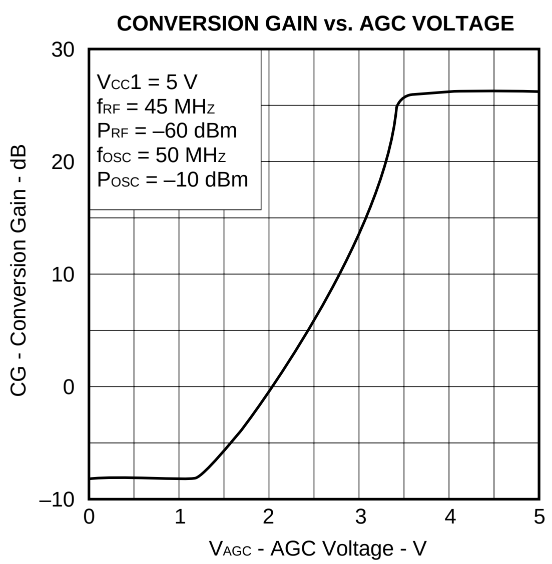
TYPICAL CHARACTERISTICS (by measurement circuit 1, T_A = 25 °C)

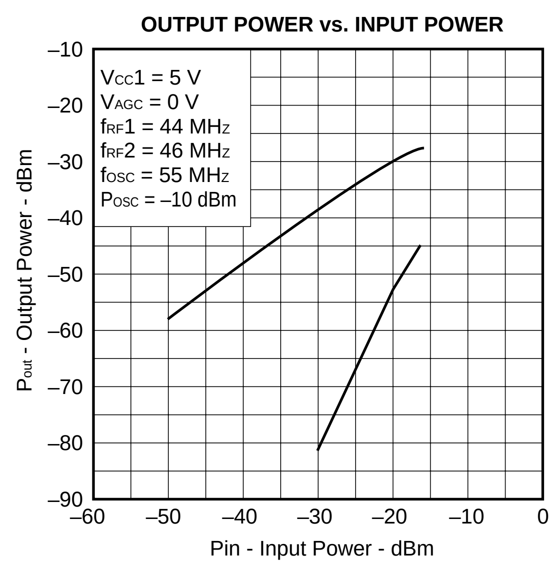






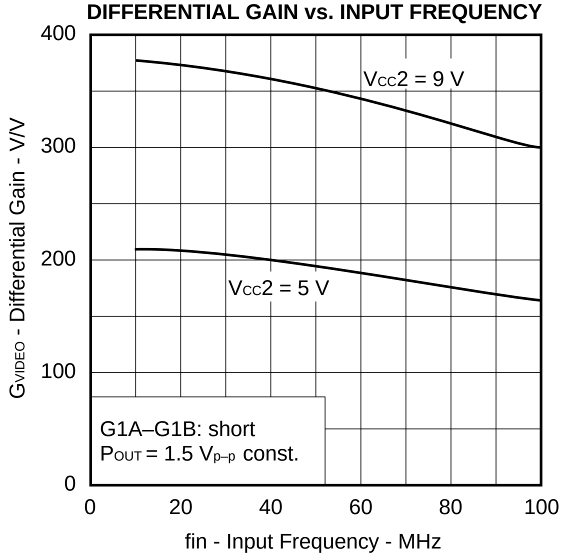




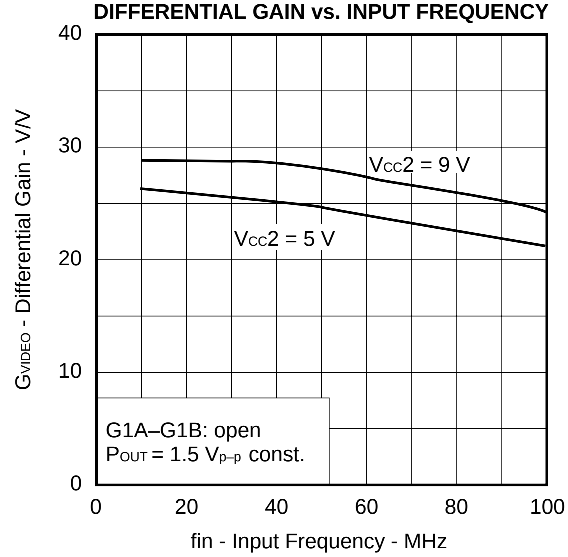


STANDARD CHARACTERISTICS (by measurement circuit 3, T_A = 25 °C)

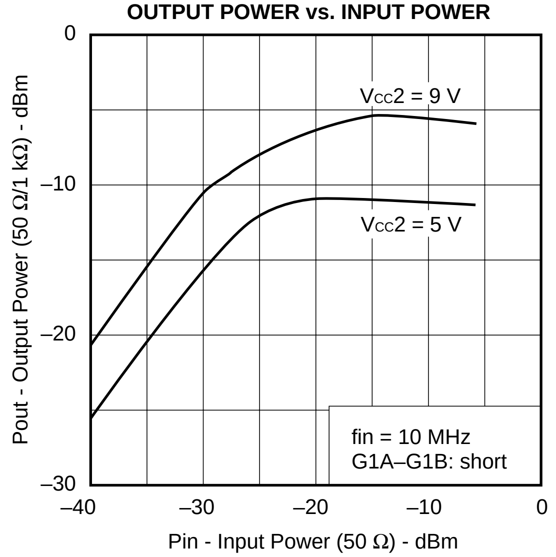
DIFFERENTIAL GAIN vs. INPUT FREQUENCY



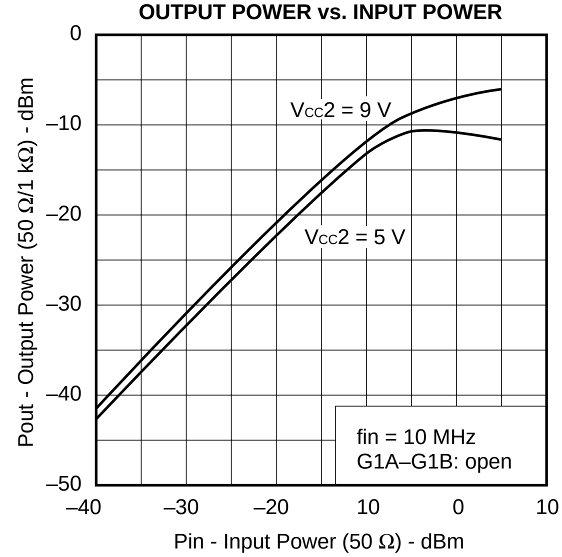
DIFFERENTIAL GAIN vs. INPUT FREQUENCY



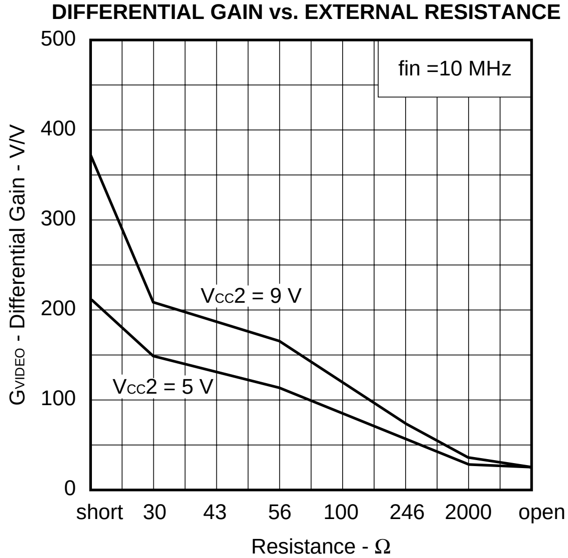
OUTPUT POWER vs. INPUT POWER



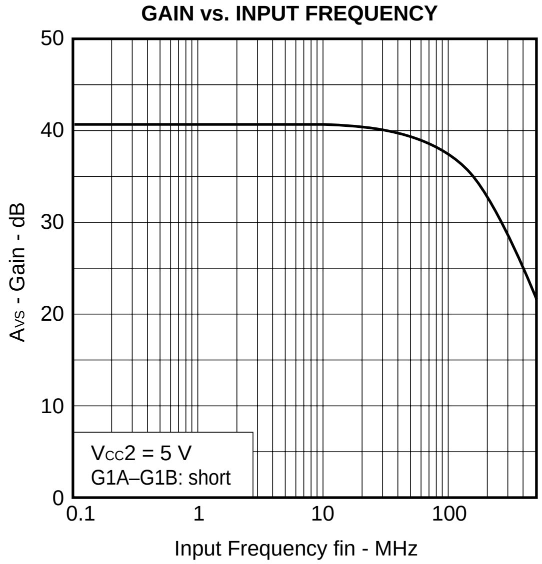
OUTPUT POWER vs. INPUT POWER

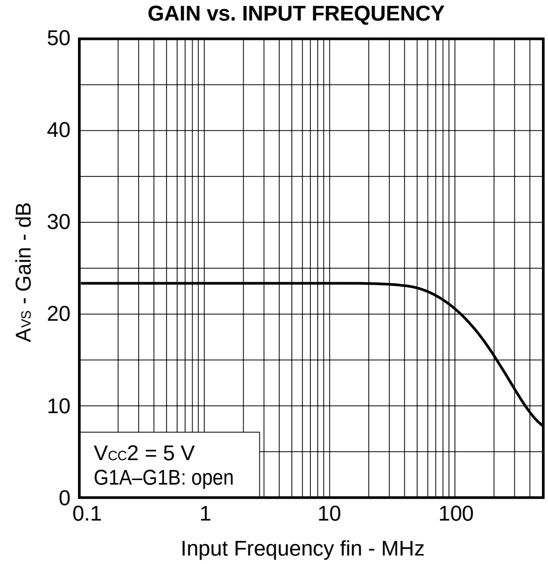


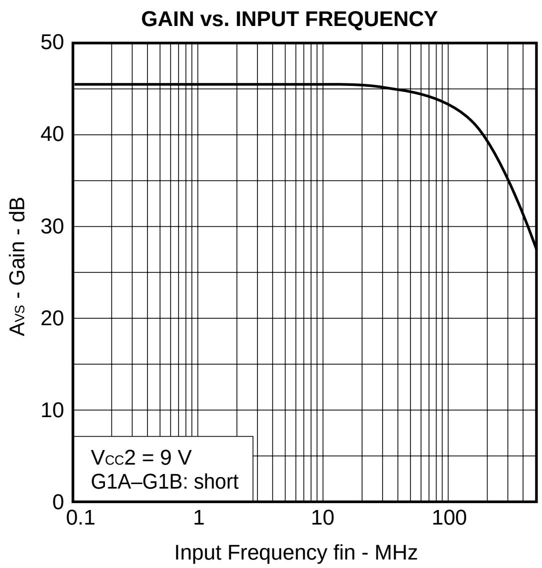
DIFFERENTIAL GAIN vs. EXTERNAL RESISTANCE

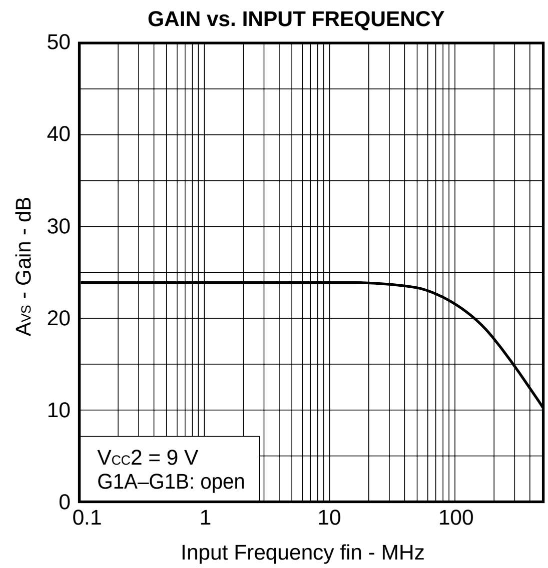


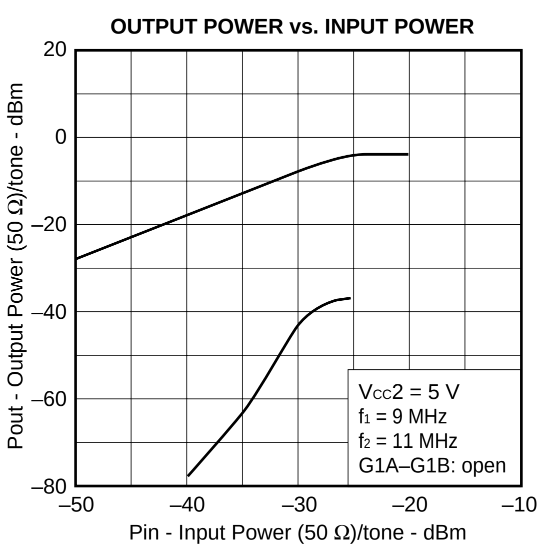
STANDARD CHARACTERISTICS (by measurement circuit 4, T_A = 25 °C)

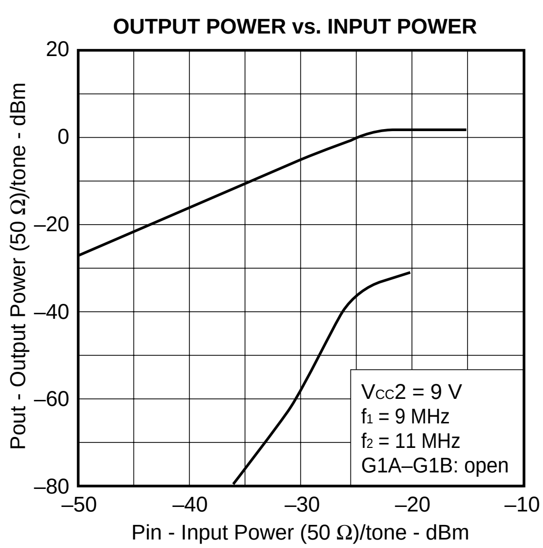




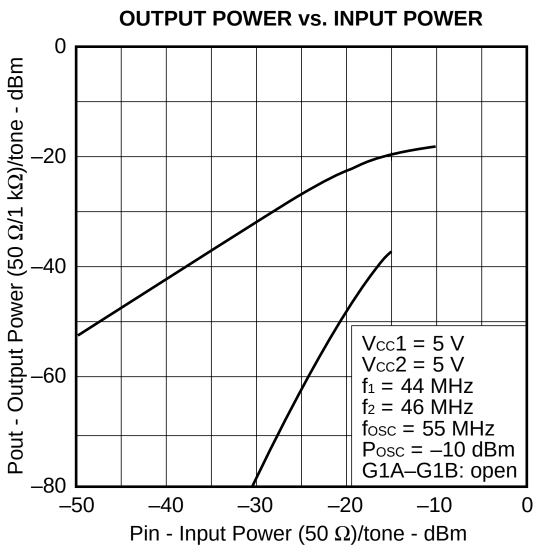


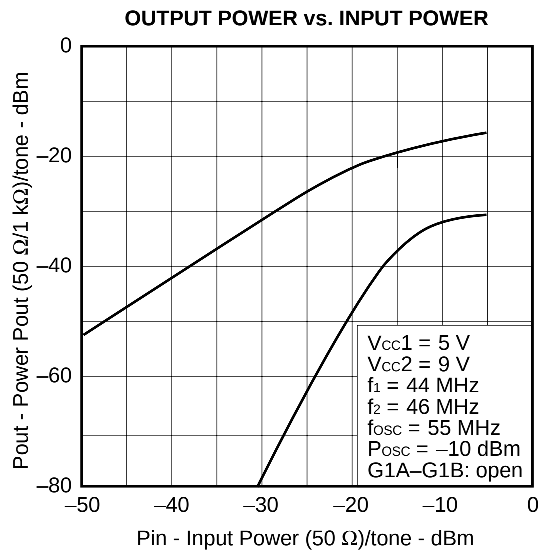


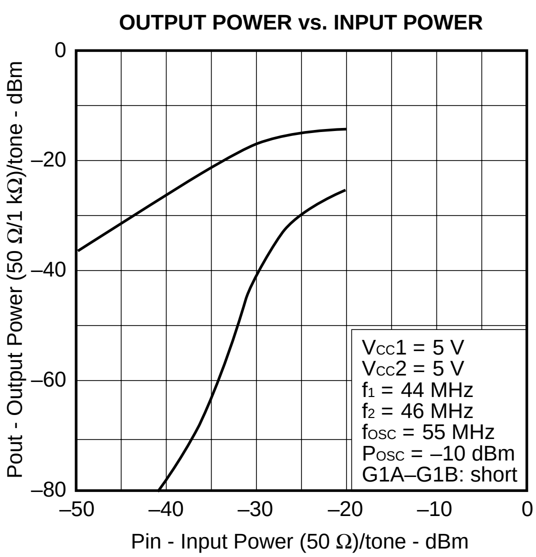




STANDARD CHARACTERISTICS (by measurement circuit 5)

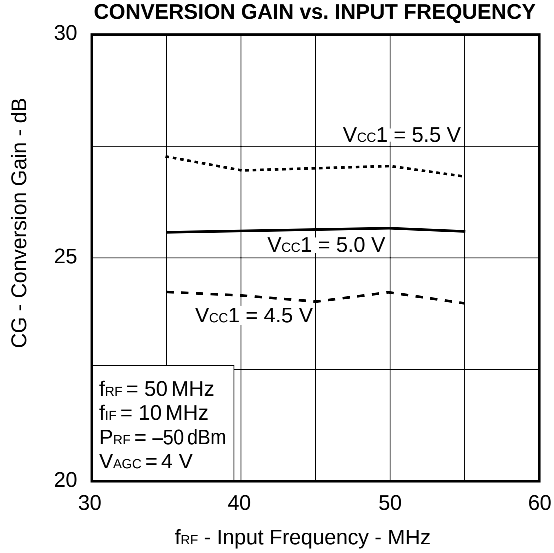




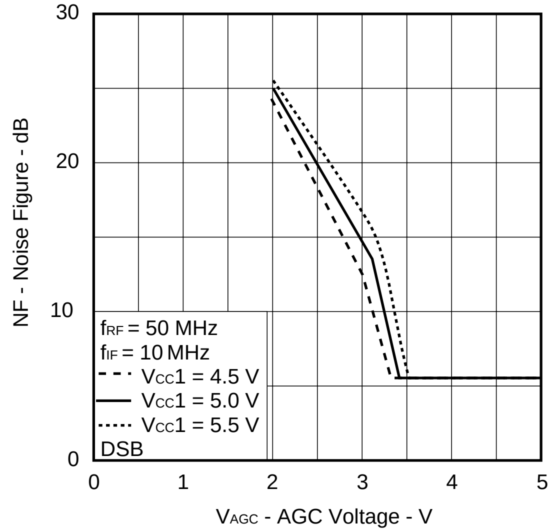


STANDARD CHARACTERISTICS
(by application circuit example: MIXER block, T_A = 25 °C)

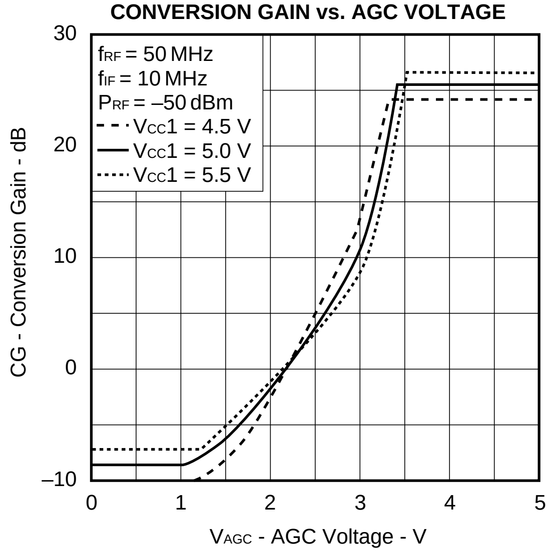
CONVERSION GAIN vs. INPUT FREQUENCY



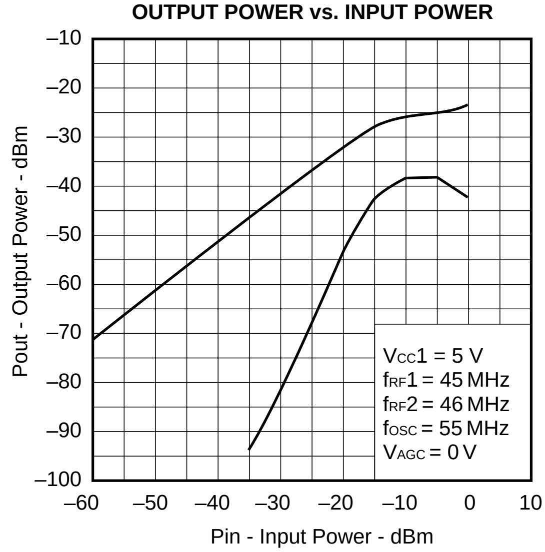
NOISE FIGURE vs. AGC VOLTAGE



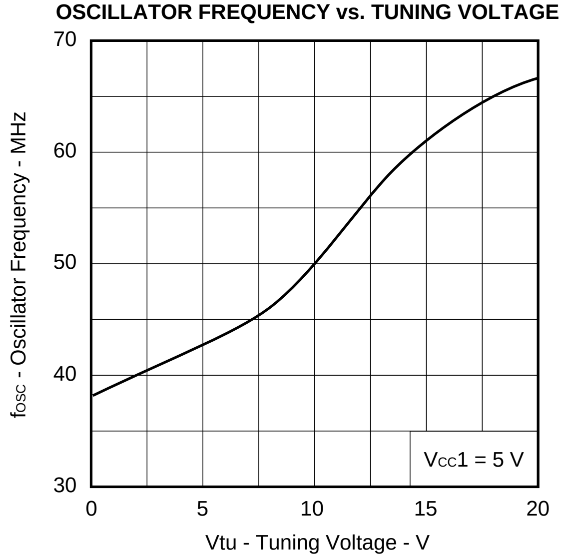
CONVERSION GAIN vs. AGC VOLTAGE



OUTPUT POWER vs. INPUT POWER

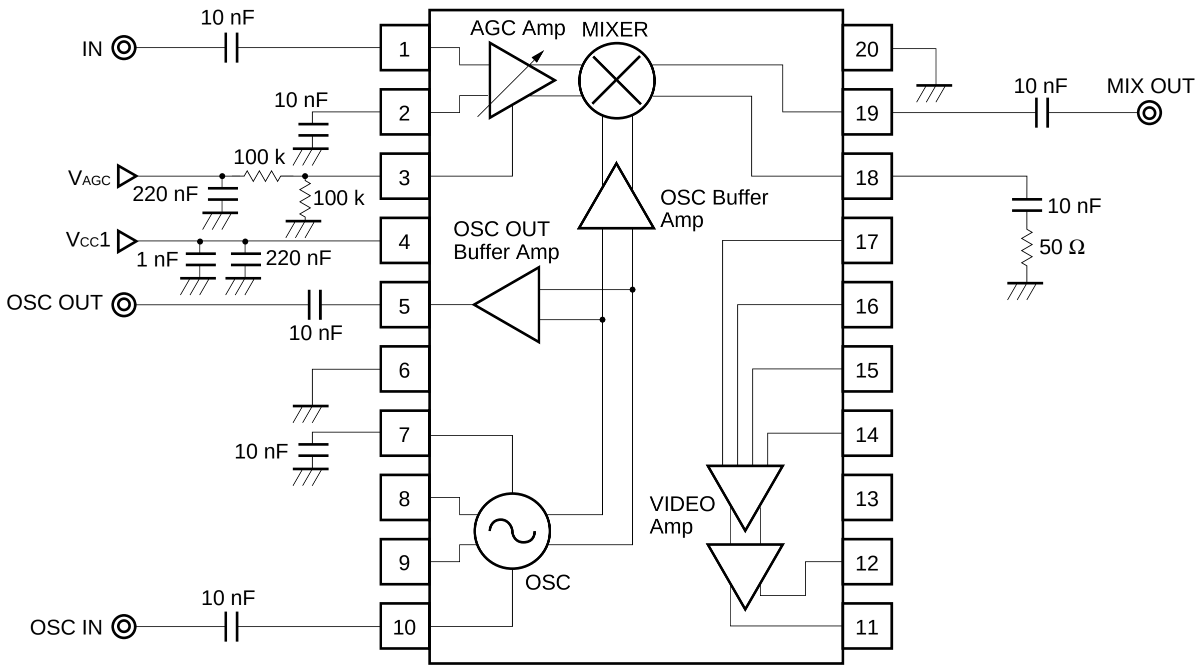


OSCILLATOR FREQUENCY vs. TUNING VOLTAGE



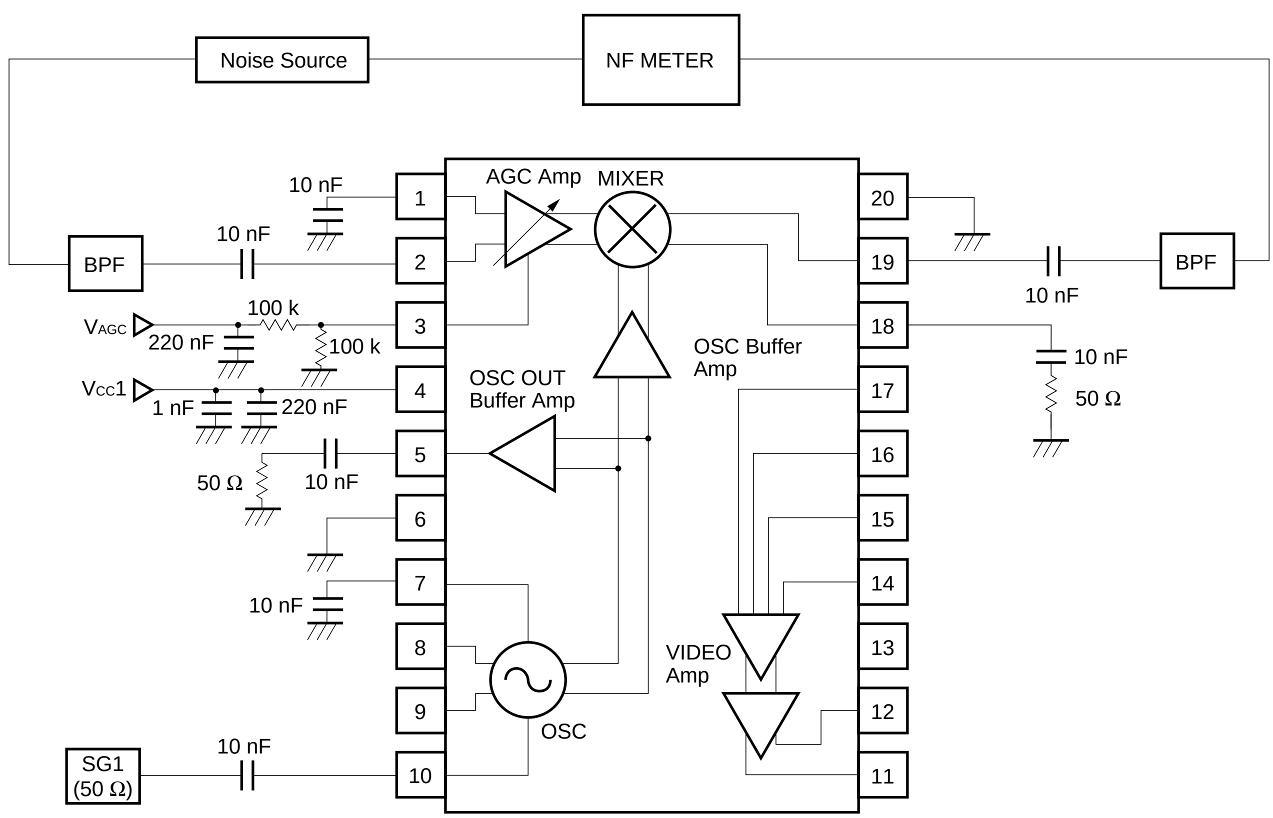
MEASUREMENT CIRCUIT 1

<AGC + MIX block>



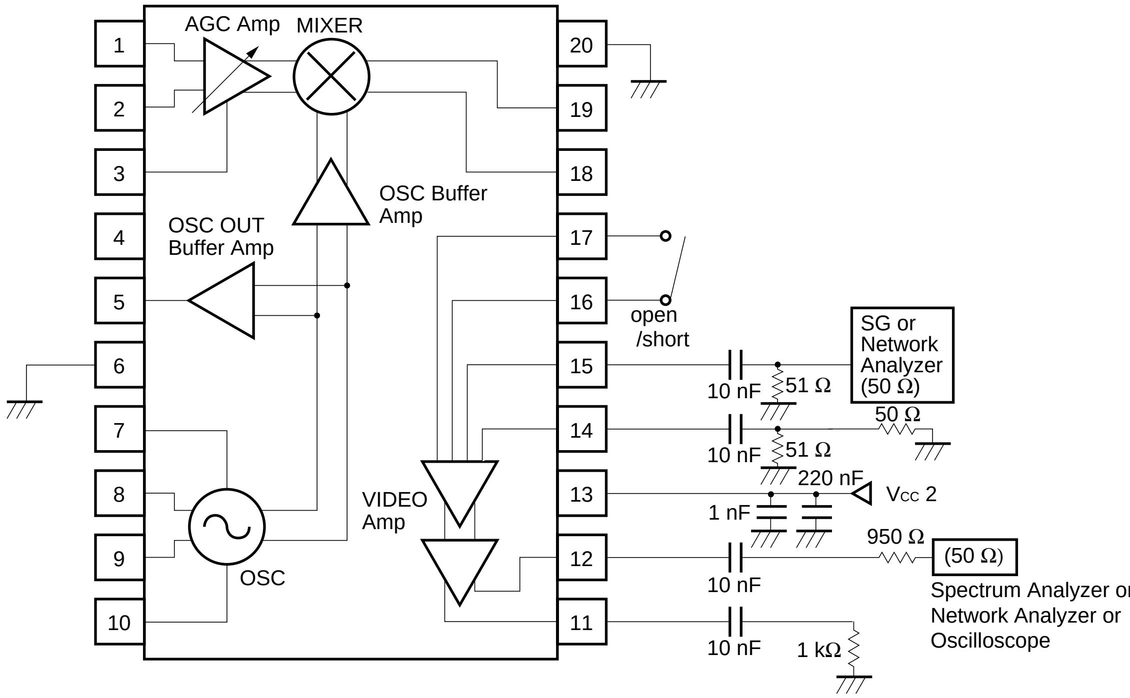
MEASUREMENT CIRCUIT 2

<AGC + MIX block>



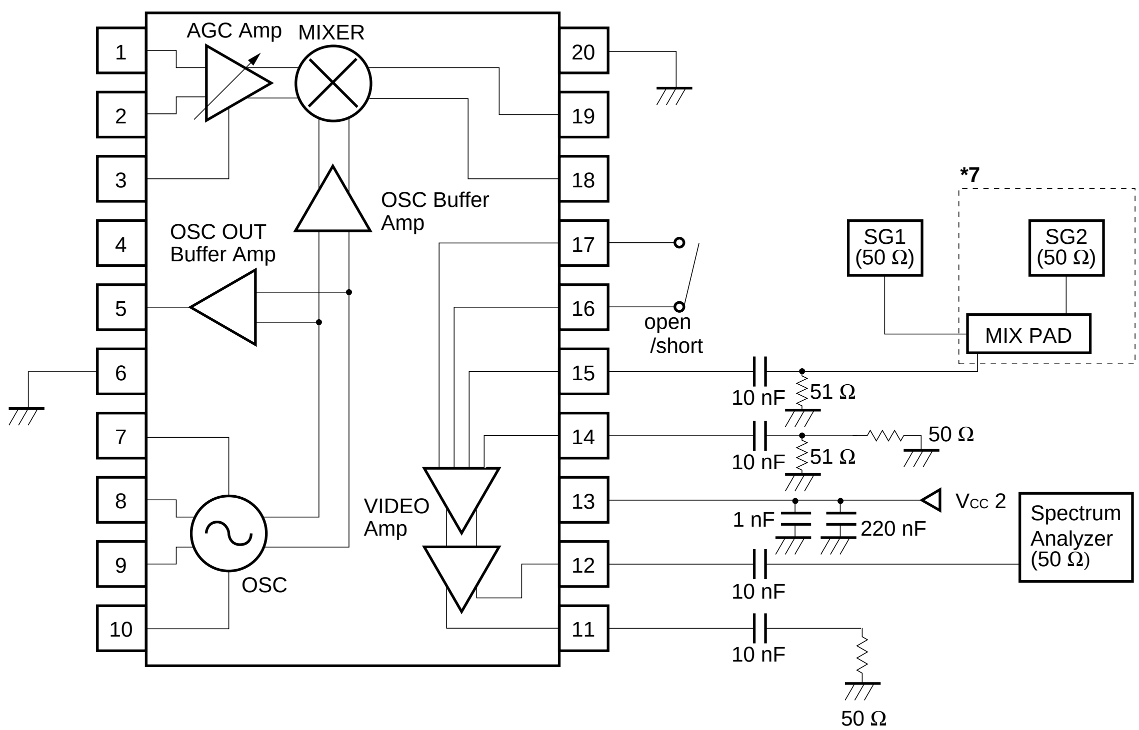
MEASUREMENT CIRCUIT 3

<Video Amp. block>



MEASUREMENT CIRCUIT 4

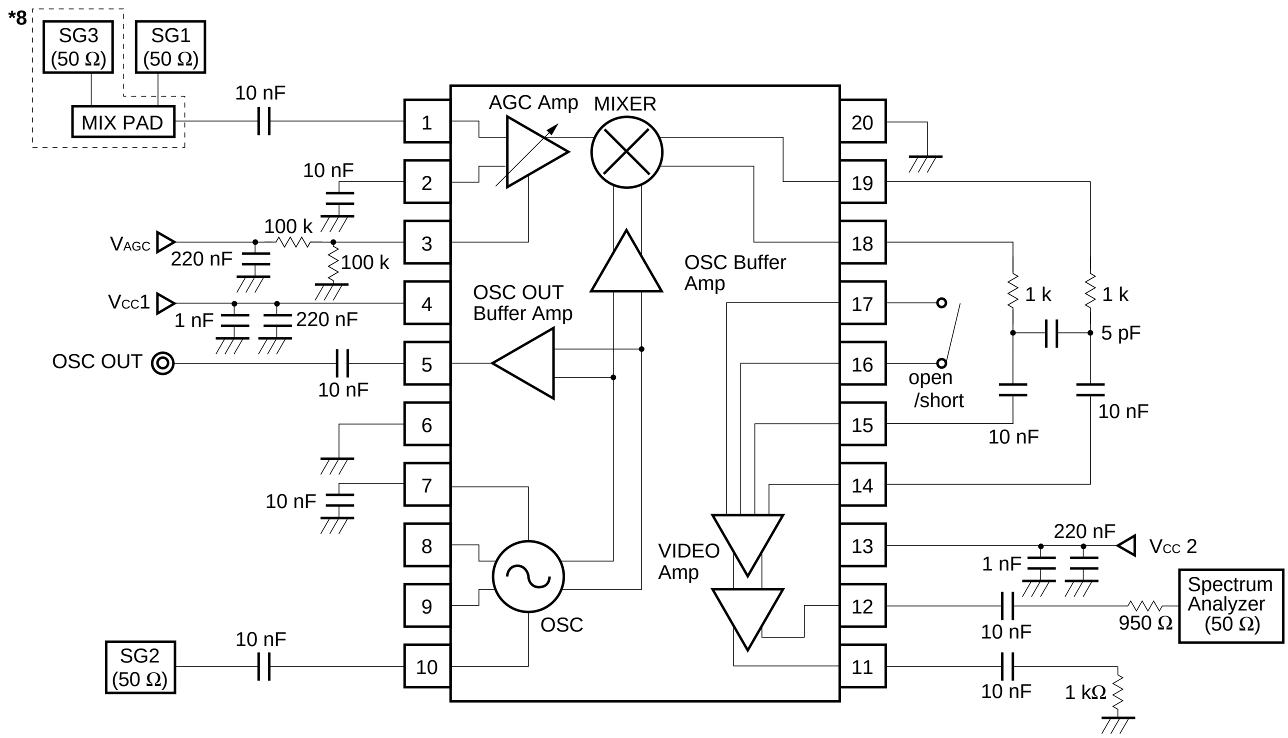
<Video Amp. block>



***7:** In case of measurement of IIP3

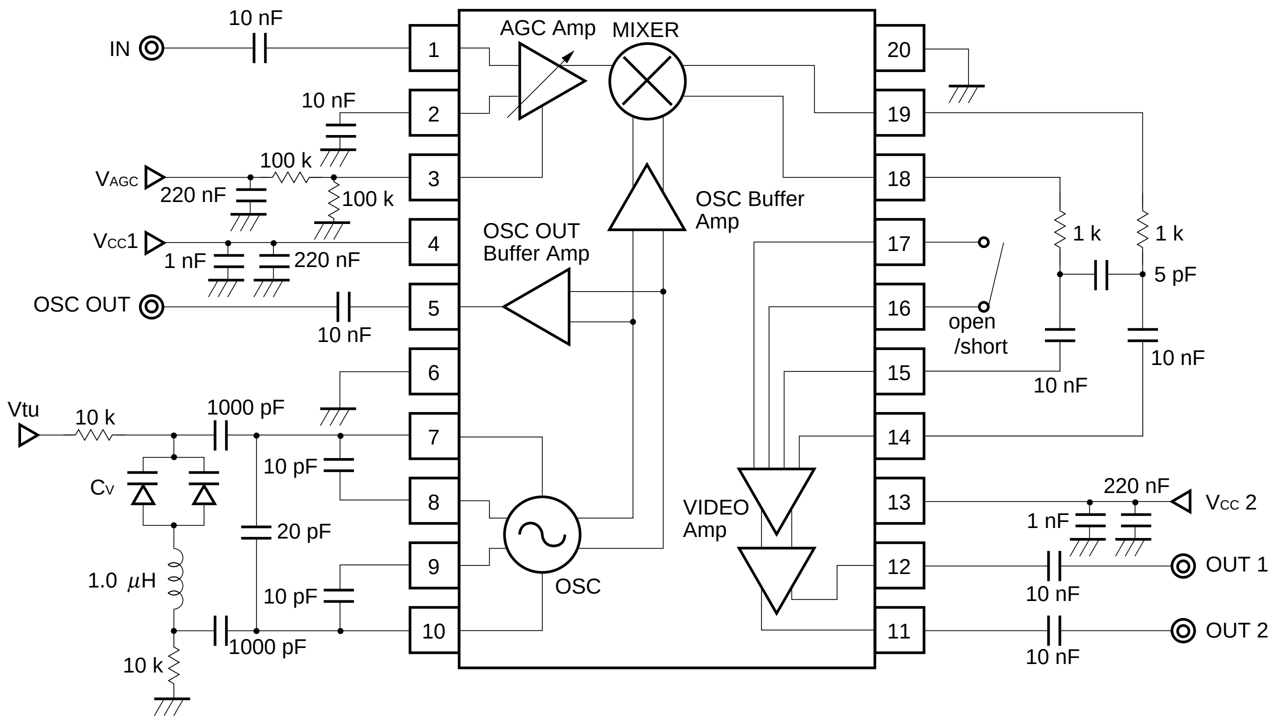
MEASUREMENT CIRCUIT 5

<Total block>



***8**: In case of measurement of IIP3

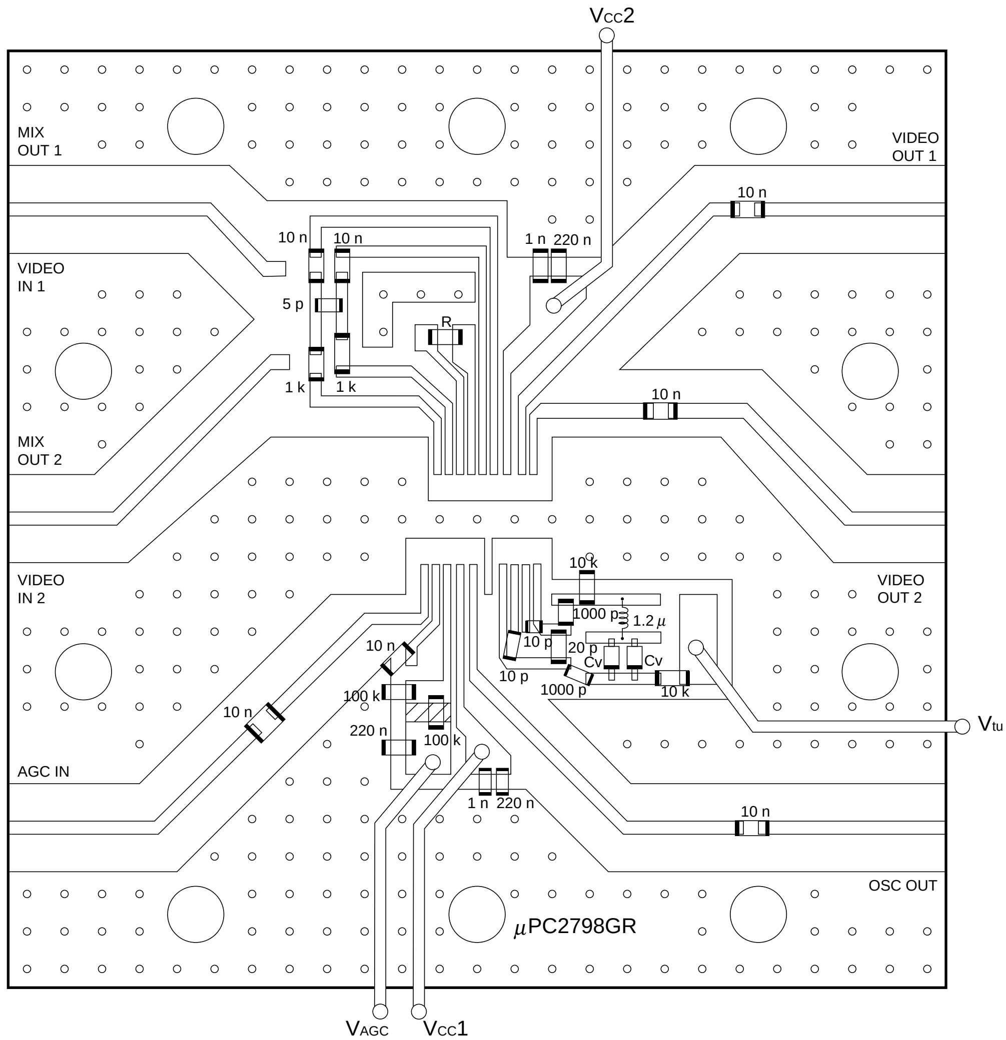
APPLICATION CIRCUIT EXAMPLE



C_V: N ratio = 10 to 11 (ex. HVU 200 A)

The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

ILLUSTRATION OF THE APPLICATION CIRCUIT ASSEMBLED ON EVALUATION BOARD



Notes

***1)** R is resistance to control video amplifier gain. (short to open)

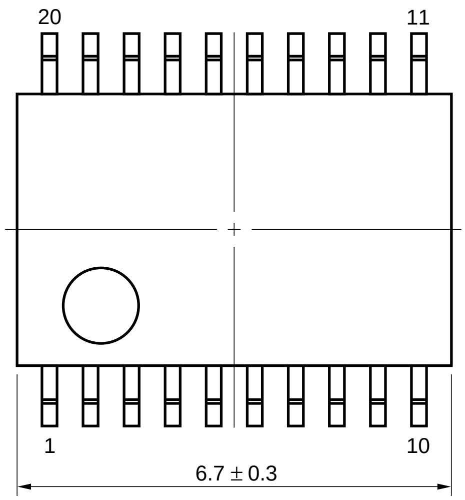
***2)** C_V is variable capacitor. (N ratio = 10 to 11, Example: HVU200A)

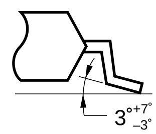
***3)** ○◯ shows through holes

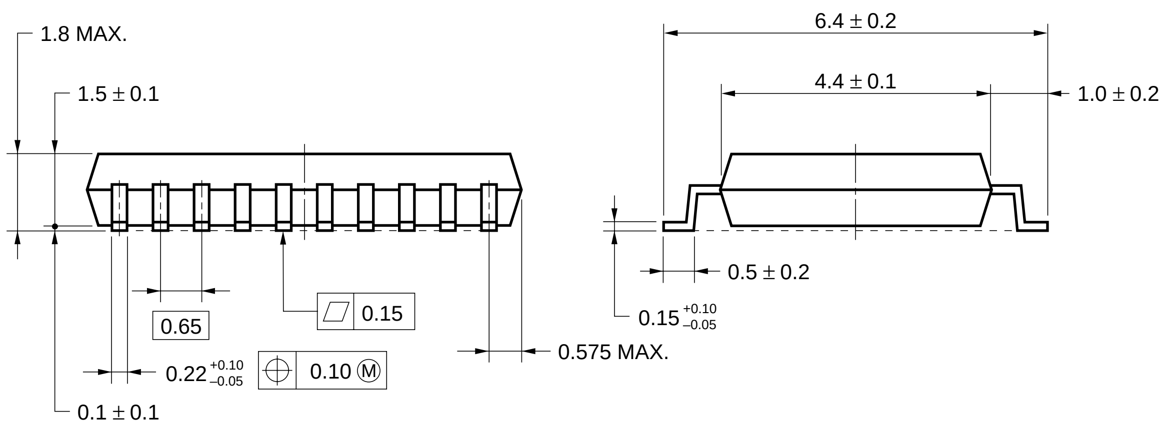
***4)** ▨ pattern should be removed on this application

PACKAGE DIMENSIONS

★ **20 PIN PLASTIC SSOP (225 mil) (UNIT: mm)**







NOTE Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.

RECOMMENDED SOLDERING CONDITIONS

The following conditions (see table below) must be met when soldering this product.

Please consult with our sales officers in case other soldering process is used or in case soldering is done under different conditions.

For details of recommended soldering conditions for surface mounting, refer to information document **SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (C10535E).**

***μ*PC2798GR**

Soldering process	Soldering conditions	Symbol
Infrared ray reflow	Peak package's surface temperature: 235 °C or below, Reflow time: 30 seconds or below (210 °C or higher), Number of reflow process: 3, Exposure limit[Note]: None	IR35-00-3
VPS	Peak package's surface temperature: 215 °C or below, Reflow time: 40 seconds or below (200 °C or higher), Number of reflow process: 3, Exposure limit[Note]: None	VP15-00-3
Partial heating method	Terminal temperature: 300 °C or below, Flow time: 3 seconds or below, Exposure limit[Note]: None	

Note Exposure limit before soldering after dry-pack package is opened.
Storage conditions: 25 °C and relative humidity at 65% or less.

Caution Do not apply more than single process at once, except for "Partial heating method".

[MEMO]

[MEMO]

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