## FREQUENCY DOWN CONVERTER FOR VHF TO UHF BAND TV/VCR TUNER

## DESCRIPTION

The $\mu$ PC2797GR is a Silicon monolithic IC designed for TV/VCR tuner applications. This IC consists of a double balanced mixer (DBM), local oscillator, preamplifier for precscaler operation, IF amplifier, regulator, UHF/VHF switching circuit, and so on. This one-chip IC covers a wide frequency band from VHF to UHF bands. This IC is packaged in 20-pin SSOP (Shrink Small Outline Package) suitable for surface mounting.

## FEATURES

- VHF to UHF bands operation.
- Low distortion CM: VHF (@frF $=470 \mathrm{MHz}) 96 \mathrm{~dB} \mu$

UHF (@frf $=890 \mathrm{MHz}) 92 \mathrm{~dB} \mu$

- Supply voltage 9 V
- Packaged in 20-pin SSOP suitable for surface mounting


## ORDERING INFORMATION

| Part Number | Package | Package Style |
| :---: | :---: | :---: |
| $\mu$ PC2797GR-E1 | 20-pin plastic SSOP (225 mil) | Embossed tape 12 mm wide. 2.5 k/REEL. <br> Pin 1 indicates pull-out direction of tape |

For evaluation sample order, please contact your local NEC office. (Part number for sample order: $\mu$ PC2797GR)

## Caution electro-static sensitive device

[^0]PIN CONFIGURATION (Top View)


1. UHF OSC Collector (Tr. 1)
2. UHF OSC Base (Tr. 2)
3. UHF OSC Base (Tr. 1)
4. UHF OSC Collector (Tr. 2)
5. UB
6. OSC OUTPUT
7. GND
8. VHF OSC Base (Tr. 1)
9. VHF OSC Base (Tr. 2)
10. VHF OSC Collector (Tr. 1)
11. REG
12. IF OUTPUT
13. Vcc
14. MIX OUTPUT
15. MIX OUTPUT
16. VHF RF INPUT
17. VHF RF INPUT
18. GND
19. UHF RF INPUT
20. UHF RF INPUT

## INTERNAL BLOCK DIAGRAM



## PIN EXPLANATION

| Pin No. | Symbol | Pin Voltage TYP. above: VHF mode below: UHF mode | Function and Explanation | Equivalent Circuit |
| :---: | :---: | :---: | :---: | :---: |
| 1 | UOSC <br> collector (Tr. 1) | 6.90 6.25 | Collector pin of UHF oscillator. Assemble LC resonator with 2 pin through capacitor $\simeq 1 \mathrm{pF}$ to oscillate with active feedback loop. |  |
| 2 | UOSC <br> base (Tr.2) | 6.00 3.90 | Base pin of UHF oscillator with balance amplifier. Connected to LC resonator through feedback capacitor $\sim 300 \mathrm{pF}$. |  |
| 3 | UOSC <br> base (Tr. 1) | $\begin{aligned} & 6.00 \\ & \hline 3.90 \end{aligned}$ | Base pin of UHF oscillator with balance amplifier. Connected to LC resonator through feedback capacitor $\sim 300 \mathrm{pF}$. |  |
| 4 | UOSC <br> collector (Tr. 2) | 6.90 | Collector pin of UHF oscillator with balance amplifier. Assemble LC resonator with 3 pin through capacitor $\simeq 1 \mathrm{pF}$ to oscillate with active feedback loop. <br> Double balanced oscillator with transistor 1 and transistor 2. |  |
| 5 | UB | 9.0 | Switching pin for VHF or UHF operation. <br> VHF operation $=$ open <br> UHF operation $=9.0 \mathrm{~V}$ |  |
| 6 | OSC <br> output | 5.85 | UHF and VHF oscillator output pin. In case of F/S tuner application, connected PLL symthesizer IC's input pin. Grounded through $1.5 \mathrm{k} \Omega$ resistor. |  |
| 7 | GND | 0.0 0.0 | GND pin of VHF and UHF oscillator. |  |
| 8 | vosc base <br> (Tr. 1) | 3.50 5.90 | Base pin of VHF oscillator. Grounded through capacitor $\simeq$ 10 pF . |  |
| 9 | vosc base (Tr. 2) | 3.50 5.90 | Base pin of VHF oscillator. Assemble LC resonator with 10 pin to oscillate with active feedback loop. |  |
| 10 | VOSC collector (Tr. 1) | 6.20 6.90 | Collector pin of VHF oscillator. Connected to LC resonator through feedback capacitor $\simeq 3 \mathrm{pF}$. |  |



ABSOLUTE MAXIMUM RATINGS ( $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ unless otherwise specified)

| Parameter | Symbol | Condition | Rating | Unit |
| :--- | :---: | :---: | :---: | :---: |
| Supply Voltage 1 | $\mathrm{V}_{\mathrm{Cc}}$ |  | 11.0 | V |
| Supply Voltage 2 | UB |  | 11.0 | V |
| Power dissipation | $\mathrm{PD}_{\mathrm{D}}$ | $\mathrm{T}_{\mathrm{A}}=75^{\circ} \mathrm{C}^{*} 1$ | 500 | mW |
| Operating Ambient Temperature | $\mathrm{T}_{\mathrm{A}}$ |  | -40 to +75 | ${ }^{\circ} \mathrm{C}$ |
| Storage temperature | $\mathrm{T}_{\text {stg }}$ |  | -60 to +150 | ${ }^{\circ} \mathrm{C}$ |

*1 Mounted on $50 \times 50 \times 1.6 \mathrm{~mm}$ double copper epoxy glass board.

## RECOMMENDED OPERATING RANGE

| Parameter | Symbol | MIN. | TYP. | MAX. | Unit |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Supply voltage 1 | $\mathrm{V}_{\mathrm{CC}}$ | 8.0 | 9.0 | 10.0 | V |
| Supply voltage 2 | UB | 8.0 | 9.0 | 10.0 | V |
| Operating Ambient Temperature | $\mathrm{T}_{\mathrm{A}}$ | -20 | +25 | +75 | ${ }^{\circ} \mathrm{C}$ |

ELECTRICAL CHARACTERISTICS ( $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}, \mathrm{Vcc}=9 \mathrm{~V}, \mathrm{fiF}^{\circ}=45 \mathrm{MHz}$ )

| Parameter | Symbol | Test Conditions |  | MIN. | TYP. | MAX. | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Circuit Current 1 | Icc1 | @VHF, no input signal | *1,2 | 31 | 38 | 45 | mA |
| Circuit Current 2 | Icc2 | @UHF, no input signal | *1,2 | 31 | 38 | 45 | mA |
| Conversion Gain 1 | CG1 | $\begin{aligned} & \mathrm{frF}=55 \mathrm{MHz}, \mathrm{PrF}_{\mathrm{PF}}=-30 \mathrm{dBm} \\ & \mathrm{Posc}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 18.5 | 22.0 | 25.5 | dB |
| Conversion Gain 2 | CG2 | $\begin{aligned} & f_{R F}=200 \mathrm{MHz}, P_{R F}=-30 \mathrm{dBm} \\ & P_{\text {osc }}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 18.5 | 22.0 | 25.5 | dB |
| Conversion Gain 3 | CG3 | $\begin{aligned} & f_{\text {RF }}=470 \mathrm{MHz}, \mathrm{P}_{\mathrm{RF}}=-30 \mathrm{dBm} \\ & \mathrm{Posc}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 18.5 | 22.0 | 25.5 | dB |
| Conversion Gain 4 | CG4 | $\begin{aligned} & f_{\text {RF }}=470 \mathrm{MHz}, \mathrm{P}_{\mathrm{RF}}=-30 \mathrm{dBm} \\ & \mathrm{Posc}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 24.5 | 28.0 | 31.5 | dB |
| Conversion Gain 5 | CG5 | $\begin{aligned} & f_{R F}=890 \mathrm{MHz}, P_{\text {RF }}=-30 \mathrm{dBm} \\ & \mathrm{Posc}^{2}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 24.5 | 28.0 | 31.5 | dB |
| Noise Figure 1 | NF1 | $\mathrm{f}_{\mathrm{RF}}=55 \mathrm{MHz}$, Posc $=-10 \mathrm{dBm}$ | * 4 | - | 11.0 | 14.0 | dB |
| Noise Figure 2 | NF2 | $\mathrm{ffF}=200 \mathrm{MHz}$, Posc $=-10 \mathrm{dBm}$ | *4 | - | 11.0 | 14.0 | dB |
| Noise Figure 3 | NF3 | $\mathrm{frF}^{\text {a }}=470 \mathrm{MHz}, \mathrm{Posc}=-10 \mathrm{dBm}$ | *4 | - | 11.0 | 14.0 | dB |
| Noise Figure 4 | NF4 | $\mathrm{ffF}_{\text {f }}=470 \mathrm{MHz}$, Posc $=0 \mathrm{dBm}$ | *4 | - | 9.5 | 12.5 | dB |
| Noise Figure 5 | NF5 | $\mathrm{ffF}_{\text {f }}=890 \mathrm{MHz}$, Posc $=0 \mathrm{dBm}$ | *4 | - | 10.0 | 13.0 | dB |
| Maximum Output Power 1 | Po (sat) 1 | $\begin{aligned} & \mathrm{fRF}=55 \mathrm{MHz}, \mathrm{PRF}=0 \mathrm{dBm} \\ & \mathrm{Posc}^{2}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 7.0 | 10.0 | - | dBm |
| Maximum Output Power 2 | Po (sat)2 | $\begin{aligned} & f_{\mathrm{RF}}=200 \mathrm{MHz}, \mathrm{P}_{\mathrm{RF}}=0 \mathrm{dBm} \\ & \mathrm{Posc}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 7.0 | 10.0 | - | dBm |
| Maximum Output Power 3 | Po (sat) 3 | $\begin{aligned} & f_{\mathrm{RF}}=470 \mathrm{MHz}, \mathrm{P}_{\mathrm{RF}}=0 \mathrm{dBm} \\ & \mathrm{Posc}^{0}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 7.0 | 10.0 | - | dBm |
| Maximum Output Power 4 | Po (sat) 4 | $\begin{aligned} & f_{\mathrm{RF}}=470 \mathrm{MHz}, \mathrm{P}_{\mathrm{RF}}=0 \mathrm{dBm} \\ & \mathrm{Posc}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 7.0 | 10.0 | - | dBm |
| Maximum Output Power 5 | Po (sat) 5 | $\begin{aligned} & f_{R F}=890 \mathrm{MHz}, P_{R F}=0 \mathrm{dBm} \\ & \mathrm{Posc}=-10 \mathrm{dBm} \end{aligned}$ | *3 | 7.0 | 10.0 | - | dBm |

*1 no resistance of OSC output
*2 By measurement circuit 1
*3 By measurement circuit 2
*4 By measurement circuit 3

STANDARD CHARACTERISTICS (Reference Values) ( $\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}, \mathrm{Vcc}=9 \mathrm{~V}$ )

| Parameter | Symbol | Test Conditions |  | Value for Reference | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 \% cross-modulation distortion 1 | CM1 | $\begin{aligned} & f_{\text {des }}=55 \mathrm{MHz}, \mathrm{fundes}=\mathrm{f}_{\text {des }}+6 \mathrm{MHz}, \\ & \mathrm{P} \text { des }=-30 \mathrm{dBm}, \mathrm{fIF}=45 \mathrm{MHz}, \\ & \text { Posc }=-10 \mathrm{dBm}, \mathrm{AM} 100 \mathrm{kHz}, 30 \% \\ & \text { modulation, DES/CM }=46 \mathrm{dBc} \end{aligned}$ | *1 | 100 | $\mathrm{dB} \mu$ |
| 1 \% cross-modulation distortion 2 | CM2 | $\begin{aligned} & f_{\text {des }}=200 \mathrm{MHz}, \mathrm{fundes}^{=} \mathrm{f}_{\text {des }}+6 \mathrm{MHz}, \\ & \mathrm{P} \text { des }-30 \mathrm{dBm}, \mathrm{fIF}=45 \mathrm{MHz}, \\ & \text { Posc }=-10 \mathrm{dBm}, \mathrm{AM} 100 \mathrm{kHz}, 30 \% \\ & \text { modulation, DES/CM }=46 \mathrm{dBc} \end{aligned}$ | *1 | 100 | $\mathrm{dB} \mu$ |
| $1 \%$ cross-modulation distortion 3 | CM3 | $\begin{aligned} & \text { fdes }=470 \mathrm{MHz}, \text { fundes }=\mathrm{fdes}+6 \mathrm{MHz}, \\ & \text { Pdes }=-30 \mathrm{dBm}, \mathrm{fIF}=45 \mathrm{MHz}, \\ & \text { Posc }=-10 \mathrm{dBm}, \mathrm{AM} 100 \mathrm{kHz}, 30 \% \\ & \text { modulation, } \mathrm{DES} / \mathrm{CM}=46 \mathrm{dBc} \end{aligned}$ | *1 | 96 | $\mathrm{dB} \mu$ |
| 1 \% cross-modulation distortion 4 | CM4 | $\begin{aligned} & f_{\text {des }}=470 \mathrm{MHz}, \text { fundes }=\mathrm{f}_{\text {des }}+6 \mathrm{MHz}, \\ & \text { Pdes }=-30 \mathrm{dBm}, \mathrm{fIF}=45 \mathrm{MHz}, \\ & \text { Posc }=-10 \mathrm{dBm}, \mathrm{AM} 100 \mathrm{kHz}, 30 \% \\ & \text { modulation, } \mathrm{DES} / \mathrm{CM}=46 \mathrm{dBc} \end{aligned}$ | ${ }^{*}$ | 94 | dB $\mu$ |
| $1 \%$ cross-modulation distortion 5 | CM5 | $\begin{aligned} & f_{\text {des }}=890 \mathrm{MHz}, \mathrm{fundes}=\mathrm{f}_{\text {des }}+6 \mathrm{MHz}, \\ & \text { Pdes }=-30 \mathrm{dBm}, \mathrm{fIF}=45 \mathrm{MHz}, \\ & \text { Posc }=-10 \mathrm{dBm}, \mathrm{AM} 100 \mathrm{kHz}, 30 \% \\ & \text { modulation, DES/CM }=46 \mathrm{dBc} \end{aligned}$ |  | 92 | $\mathrm{dB} \mu$ |

*1 By measurement circuit 4

*1 External resistor is removed.
Pout vs. Pin


CG, NF vs. frf


Icc vs. Vcc


Pout vs. Pin


CM vs. frf


## STANDARD CHARACTERISTICS (by application circuit example)

CG, NF vs. $\mathrm{f}_{\mathrm{RF}}$


CM vs. $\mathrm{frF}_{\mathrm{F}}$


Pout vs. Pin




## INPUT IMPEDANCE (by measurement circuit 5)

<VRF INPUT: 17 PIN>

$\nabla 145 \mathrm{MHz}$
$874.28 \Omega-221.97 \Omega$
V 2200 MHz
$375.14 \Omega-369.39 \Omega$
$\nabla 3470 \mathrm{MHz}$
$98.023 \Omega-170.73 \Omega$
<URF INPUT: 20 PIN>

$\nabla 1400 \mathrm{MHz}$
$117.56 \Omega-204.60 \Omega$
$\nabla 2600 \mathrm{MHz}$
$50.523 \Omega-116.67 \Omega$
$\nabla 3890 \mathrm{MHz}$ $16.645 \Omega-54.867 \Omega$

## OUTPUT IMPEDANCE (by measurement circuit 5)

<IF OUTPUT: 12 PIN>


## MEASUREMENT CIRCUIT 1



20 $\sqrt{19} \sqrt{18} \sqrt{17} \sqrt{16} \sqrt{15} \sqrt{14} \sqrt{13} \sqrt{12} \sqrt{11}$


| 5pin Voltage |  |
| :---: | :---: |
| VHF | OPEN |
| UHF | 9 V |

## MEASUREMENT CIRCUIT 2



## MEASUREMENT CIRCUIT 3



## MEASUREMENT CIRCUIT 4



## MEASUREMENT CIRCUIT 5



## Application Circuit Example



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

## ILLUSTRATION OF THE EVALUATION BOARD FOR APPLICATION CIRCUIT EXAMPLE (Surface)



## ILLUSTRATION OF THE EVALUATION BOARD FOR APPLICATION CIRCUIT EXAMPLE (Back side)



## PACKAGE DIMENSIONS

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

detail of lead end


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

## NOTE ON CORRECT USE

(1) Observe precautions for handling because of electro-static sensitive devices.
(2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent undesires oscillation).
(3) Keep the track length of the ground pins as short as possible.
(4) A low pass filter must be attached to Vcc line.
(5) A matching circuit must be externally attached to output port.

## 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).
$\mu$ PC2797GR

| Soldering Process | Soldering Conditions | Symbol |
| :--- | :--- | :---: |
| Infrared ray reflow | Peak package's surface temperature: $235{ }^{\circ} \mathrm{C}$ or below, <br> Reflow time: 30 seconds or below $\left(210{ }^{\circ} \mathrm{C}\right.$ or higher $)$, <br> Number of reflow process: 3, Exposure limit ${ }^{\star} 1:$ None | IR35-00-3 |
| VPS | Peak package's surface temperature: $215{ }^{\circ} \mathrm{C}$ or below, <br> Reflow time: 40 seconds or below $\left(200{ }^{\circ} \mathrm{C}\right.$ or higher $)$, <br> Number of reflow process: 3, Exposure limit $1:$ None | VP15-00-3 |

*1 Exposure limit before soldering after dry-pack package is opened.
Storage conditions: $25^{\circ} \mathrm{C}$ and relative humidity at $65 \%$ or less.

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

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