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LA72912V

Monolithic Linear IC FM Modulator and Demodulator IC

Overview

The LA72912V is a FM modulation and demodulation single-chip IC. Its adjustment free modulation/demodulation circuit significantly reduces the number of peripheral circuits required and can contribute to lower production costs.

Functions

- ASK modulation and demodulation
- Video signal FM modulation and demodulation
- Video signal emphasis and de-emphasis function
- Drop-Out detecting function of Video FM signal
- FM mute function at Second-Call

Specifications

Maximum Ratings at $T_a = 25^\circ\text{C}$

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------|----------------------|-------------------------------|-------------|------------------|
| Maximum supply voltage | $V_{CC \text{ max}}$ | | 7.0 | V |
| Allowable power dissipation | $P_d \text{ max}$ | | 300 | mW |
| Operating temperature | T_{opr} | $T_a \leq 70^\circ\text{C}^*$ | -30 to +70 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | -40 to +150 | $^\circ\text{C}$ |

* Mounted on a 114.3mm × 76.1mm × 1.6mm, glass epoxy board.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Recommended Operating Conditions at $T_a = 25^\circ\text{C}$

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------------|---------------------|---|------------|------|
| Recommended supply voltage | V_{CC} | | 5.0 | V |
| Allowable operating voltage range | $V_{CC \text{ op}}$ | $T_a = -30 \text{ to } +70^\circ\text{C}$ | 4.7 to 5.5 | V |

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Electrical Characteristics at Ta = 25°C, VCC = 5V

DC CHARACTERISTICS T6 = 0.4V, T17 = 2.0V, T18 = 0.4V

| Parameter | Symbol | In | OUT | Conditions | Ratings | | | Unit |
|--------------------------------------|-----------------|------|-----|---|---------|------|------|-------|
| | | | | | min | typ | max | |
| Control terminal (Pin6,9) Low level | CNT6L CNT17L | T6 | T17 | Low level of control terminal of ALL mode. T6 = 0.4V(DEMOD mode), T17 = 0.4V (Standby mode) | 0 | | 0.4 | V |
| Control terminal (Pin6,9) High level | CNT6H CNT17H | T6 | T17 | High level of input terminal of ALL mode T6 = 2.0V (MOD mode), T17 = 2.0V (Normal mode) | 2.0 | | 5.0 | V |
| Input5 Low level | IN5L | T5 | | Low level of input terminal of MOD mode T6 = 2.0V, T17 = 2.0V, T18 = 0.4V | 0 | | 0.4 | V |
| Input5 High level | IN5H | T5 | | High level of input terminal of MOD mode T6 = 2.0V, T17 = 2.0V, T18 = 0.4V | 2.0 | | 5.0 | V |
| Input18 Low level | IN18L | T18 | | Low level of input terminal of MOD mode T5 = 0.4V, T6 = 2.0V, T17 = 2.0V | 0 | | 0.4 | V |
| Input18 High level | IN18H | T18 | | High level of input terminal of MOD mode T5 = 0.4V, T6 = 2.0V, T17 = 2.0V | 2.0 | | 5.0 | V |
| Output18 terminal High level | OPH18 | | T18 | DEMOD mode: FM-Signal input T6 = 0.4V, T17 = 2.0V, Pull-UP: 15KΩ | 4.7 | | | V |
| Output18 terminal Low level | OPL13 OPL18 | | T18 | T18: DEMOD mode: FM No-signal Measure the sink level of output terminal. T6 = 0.4V, T17 = 2.0V, Pull-UP: 15KΩ | 0 | 0.25 | 0.4 | V |
| Input20 Low level | IN20L | T20 | T20 | Voltage of terminal at AGC ON T6 = 0.4V, T17 = 2.0V | 0 | | 3 | V |
| Input20 High level | IN20H | T20 | T20 | Voltage of terminal at AGC OFF T6 = 0.4V, T17 = 2.0V | 4.5 | | 5.0 | V |
| 5pin AC input dynamic range | ACIN5 | T5A | T3 | Input amplitude level of FM signal Freq: 11.5MHz to 13.5MHz | | | 1000 | mVp-p |
| 16pin AC input dynamic range | ACIN16 | T24A | T3 | Maximum input level of T24A at Video signal | | | 1.5 | Vp-p |

Video FM Modulation Block (MOD) T6=2.0V, T17=2.0V, T18=0.4V

| Parameter | Symbol | In | OUT | Conditions | Ratings | | | Unit |
|---|--------|------|-----|---|---------|------|------|-------|
| | | | | | min | typ | max | |
| Current dissipation | ICC R | | | measure the currents into pins 2 (MOD mode) | 22.0 | 27.0 | 32.0 | mA |
| FM modulator output level | VFM1 | | T3 | Measure the output level on T3 (No signal input) It is load impedance 200Ω between T3-GND. | | 1.8 | 2.2 | Vp-p |
| FM Mute output level | VFM2 | | T3 | Measure the T3 output level with 2nd call | 0 | 10 | 20 | mVp-p |
| Carrier frequency | FFM | | T3 | Measure the output frequency on T3 with no signal input | 10.9 | 11.5 | 12.1 | MHz |
| FM output Second harmonic distortion | THD2 | | T3 | Measure the second harmonics distortion with the above condition | | -30 | -20 | dB |
| Deviation | DEV | T24A | T3 | With T24A 100% White 1Vp-p signal, Measure the deviation on T3 | 1.9 | 2.0 | 2.1 | MHz |
| FM modulator linearity (11.5MHz to 13.5MHz) | LMOD | T24A | T3 | Let f2.85, f3.35 and f3.85 be the output frequency when 2.85V, 3.35V and 3.85V is applied to T24A $L_{MOD} = \frac{f_{3.35} - (f_{3.85} + f_{2.85}) / 2}{f_{3.85} - f_{2.85}} \times 100$ | -2 | 0 | +2 | % |
| Emphasis gain | GEMP | T24A | T20 | With VIN a 300mVp-p 10kHz sine wave, Measure the ratio of the levels on T24A and T20 | -7.5 | -6.0 | -4.5 | dB |
| Main linear emphasis characteristics(1) | GME1 | T24A | T20 | With VIN a 300mVp-p 500kHz sine wave, Measure the ratio of the levels on T24A and T20 | 0.0 | 1.5 | 3.0 | dB |
| Main linear emphasis characteristics(2) | GME2 | T24A | T20 | With VIN a 300mVp-p 2MHz sine wave, Measure the ratio of the levels on T24A and T20 | 4.0 | 5.5 | 7.0 | dB |
| White clipping level | LWC | T24A | T20 | With VIN a 1.5Vp-p 100% white video signal. Measure the white clipping level on T20 | 180 | 200 | 220 | % |
| Dark clipping level | LDC | T24A | T20 | With VIN a 1.5Vp-p 100% white video signal. Measure the dark clipping level on T20. | -60 | -50 | -40 | % |
| FM stop beginning delay time (VD characteristic 1B) | TC1 | T5 | T3 | C7 = 0.01μF, Time from fall of T5 signal to doing of FM carrier of T3 STOP | 240 | 300 | 360 | μs |
| FM stop time (VD characteristic 2A) | TC2 | T5 | T3 | C8 = 0.001μF, Stop time of FM carrier of T3 | 30 | 40 | 50 | μs |
| Minimum VD pulse width | VDT | T5 | T3 | C7 = 0.01μF, Minimum VD pulse width to which TC1B is normally output | 63 | | | μs |

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Video FM De-modulation Block (DEM0D) T6=0.4V,T17=2.0V

| Parameter | Symbol | In | OUT | Conditions | Ratings | | | Unit |
|--|----------------------------|------------|------------|---|---------|------|------|-------|
| | | | | | min | typ | max | |
| Current dissipation | I _{CCP} | | | Measure the currents into pin 2 (DEM0D mode) | 26.0 | 32.0 | 38.0 | mA |
| Video output level | V _{OUT} | T5A | T3 | Demodulation level, when the FM signal of 2.2MHz deviation. Load impedance = 1kΩ T3-GND. | 2.09 | 2.2 | 2.31 | Vp-p |
| Video output level B | V _{OUTB} | T5A | T3 | Demodulation level, when the FM signal of 2.0MHz deviation. Load impedance = 1kΩ T3-GND. (In this case only, V _{CC} make 4.5V to 5.5V.) | 1.9 | 2.0 | 2.1 | Vp-p |
| FM stop detection level (DOC characteristic 1) | DOC1 | T5A T20 | T18 T20 | T5 = 11.5MHz, 300mVp-p. Measure T20 voltage (V20). Set T20 V20 (AGC-Fix). T5 input level when T5 amplitude is decrease gradually, and T18 becomes "Low" | | 40 | 60 | mVp-p |
| (Drop Delay Down) | DDD | T5A T20 | T18 T20 | Shift time from T5 = 300mVp-p → 0mVp-p to T18 "Low". | 0.5 | 1.5 | 2.5 | μs |
| FM return judgment level | DOC2 | T5A T20 | T18 T20 | T5 = 11.5MHz, 300mVp-p, Measure T20 Voltage (V20). Set T20 V20 (AGC-Fix). T5 inputs the level when T5 amplitude is increase gradually, and T18 becomes "High" | | 60 | 90 | mVp-p |
| Video DC level when returning | DOC2B | T5A T20 | T23 | Confirmation of output of Video signal from T3. Measurement of DC level. | 0.5 | 1.0 | 1.5 | V |
| (Drop Delay Rise) Return operation delay time | DWR | T5A T20 | T18 T20 | Shift time from T5 = 0mVp-p → 300mVp-p to T18 "High" | 0.2 | 1.5 | 2.5 | μsec |
| 4V Regulator | VREG | | T4 | Measurement of T4 DC level. | 3.9 | 4.0 | 4.3 | V |
| Range of input Dynamic range | ACIN5 | T5A | T3 | DEV = 2.0MHz. Input amplitude level of FM signal. (T5A: 11.5MHz to 13.5MHz) | | 500 | 1000 | mVp-p |
| DG | DG | T5A | T3 | | 0 | 6 | 10 | % |
| DP | DP | T5A | T3 | | 0 | 6 | 10 | deg |
| Output voltage at mute | MUV | | T3 | Mute level measurement of T3 | 0 | 10 | 20 | IRE |
| FM demodulation voltage (11.0M) | VDEM11 VDEM12 VDEM13 | T5A | T23 | T5A = 11.0MHz, 100mVp-p, 200mVp-p and 400mVp-p. Each T23 voltage measurement | 0.3 | 0.8 | 1.3 | V |
| FM demodulation voltage (12.5M) | VDEM21 VDEM22 VDEM23 | T5A | T23 | T5A = 12.5MHz, 100mVp-p, 200mVp-p and 400mVp-p. Each T23 voltage measurement | 0.7 | 1.2 | 1.7 | V |
| FM demodulation voltage (14.0M) | VDEM31 VDEM32 VDEM33 | T5A | T23 | T5A = 14MHz, 100mVp-p, 200mVp-p and 400mVp-p Each T23 voltage measurement | 1.1 | 1.6 | 2.1 | V |
| FM demodulation linearity1,2,3 | LDEM1 LDEM2 LDEM3 | | | Calculate FM demodulation linearity LDEM1 = {[VDEM21 - (VDEM11 + VDEM31) / 2] / (VDEM31 - VDEM11)}×100 LDEM2 = {[VDEM22 - (VDEM12 + VDEM32) / 2] / (VDEM32 - VDEM12)}×100 LDEM3 = {[VDEM23 - (VDEM13 + VDEM33) / 2] / (VDEM33 - VDEM13)}×100 | -2 | 0 | +2 | % |
| FM demodulation Sensitivity1,2,3 | SDEM1 SDEM2 SDEM3 | | | Calculate FM recovery Sensitivity with consider pin 3 output level conversion ratio. SDEM1 = (VDEM31-VDEM11)/3.0 SDEM2 = (VDEM32-VDEM12)/3.0 SDEM3 = (VDEM33-VDEM13)/3.0 | 0.28 | 0.33 | 0.38 | V/MHz |
| Main linear de-emphasis amplitude | GMED | T5A | T23 | T5 = 200mVp-p FM signal (fm = 10kHz, Center Carrier = 12.5MHz, DEV = 2.0MHz) Signal level of T23 | 481 | 535 | 589 | mVp-p |
| Main linear de-emphasis Characteristics(1) | GMED1 | T5A | T23 | T5 = 200mVp-p FM signal (fm = 500kHz, Center Carrier = 12.5MHz, DEV = 2.0MHz). Signal level of T23 versus GMRD (Ratio of GMED). | -3.5 | -1.5 | +0.5 | dB |
| Main linear de-emphasis Characteristics(2) | GMED2 | T5A | T23 | T5 = 200mVp-p FM signal (fm = 2MHz, Center Carrier = 9.25MHz, DEV = 2.0MHz). Signal level of T23 versus GMRD (Ratio of GMED) | -6.5 | -4.5 | -2.5 | dB |

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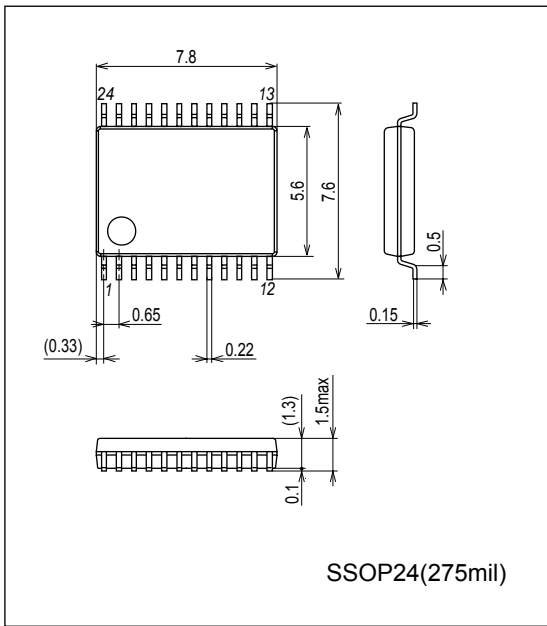
ASK Block T17=0.4V

| Parameter | Symbol | In | OUT | Conditions | Ratings | | | Unit |
|--|-------------------|-------------------|-----|--|---------|------|------|------|
| | | | | | min | typ | max | |
| Current dissipation at standby | I _{CCS} | T17 | | At standby mode, measures include current to pin2,9. T17 = 0.4V, T15 and T20:open | 10.8 | 13.0 | 15.5 | mA |
| Current dissipation at standby at MOD-AGC-OFF | I _{CCSb} | T17 T15 | | At standby mode, measures include current to pin2,9. T17 = 0.4V, T15 = 5V, T20:open | 12.8 | 16.0 | 19.2 | mA |
| Current dissipation at standby at DEMOD-AGC-OFF | I _{CCSc} | T17 T15 T20 | | At standby mode, measures include current to pin2,9. T17 = 0.4V, T15 = 5V, T20 = 5V | 16.8 | 21.0 | 25.2 | mA |
| Standby release time(1) (FM stop→release) | S _{ASK1} | T6 T17 | T3 | T6 = 2.0VDC T17 = 0V→2V (Standby release) Time until FM carrier is output to T3. | 0.0 | 6.0 | 12.0 | μs |
| Standby release time(2) (Video signal stop →release) | S _{ASK2} | T6 T5A T17 | T3 | T6 = 0.4V, T5 = DEV = 2.0MHz 100% white video signal of FM signal. T17 = 0V → 2V (Standby release) Time until white 100% signal is output to T3 | 2.0 | 7.0 | 12.0 | μs |
| ASK Transmitting time "transmission" | T _{ASK1} | T10A T11 | T12 | T10A = 1MHz,0/2V Pulse T11 = 20KHz, 0/2VPulse. Measure T12 signal appear time | | | 0.1 | ms |
| ASK Transmitting time "Receive" | T _{ASK2} | T16A | T13 | T16 = 1MHz, 300mVp-p-SIN wave Measure time T13 appear detected T16 signal | | | 0.1 | ms |
| ASK transmission setup time | W _{ASK} | T10A T11 | T12 | T10A = 1MHz, 0-2V-pulse T11 = 20KHz,0-2V-pulse Measure T11 input interval time when T10A input | | 10 | 100 | ms |
| ASK minimum detect level | V _{ASK} | T16A | T13 | Measure T16 minimum level at T13 is normally condition | 0.2 | | 3 | Vp-p |
| ASK start up time | O _{ASK} | T16A | T13 | Measure time ASK working from Power-ON | - | 30 | 300 | ms |
| ASK demodulation duty ratio | D _{ASK} | T16A | T13 | T16 = T12 output signal (0-2Vp-p) Measure ASK Duty difference with 50% DASK = (pulse width μs / 50μs) - 50% × 100% | -15 | -2 | 11 | % |

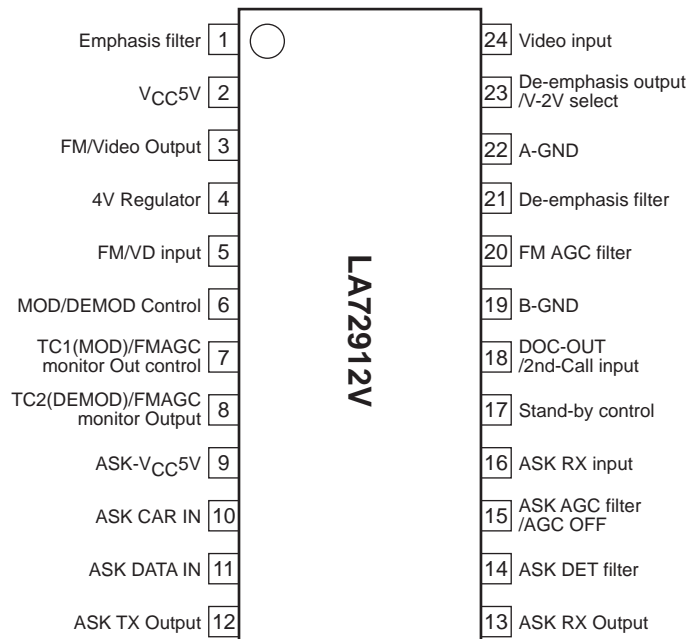
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Package Dimensions

unit : mm (typ)
3175C



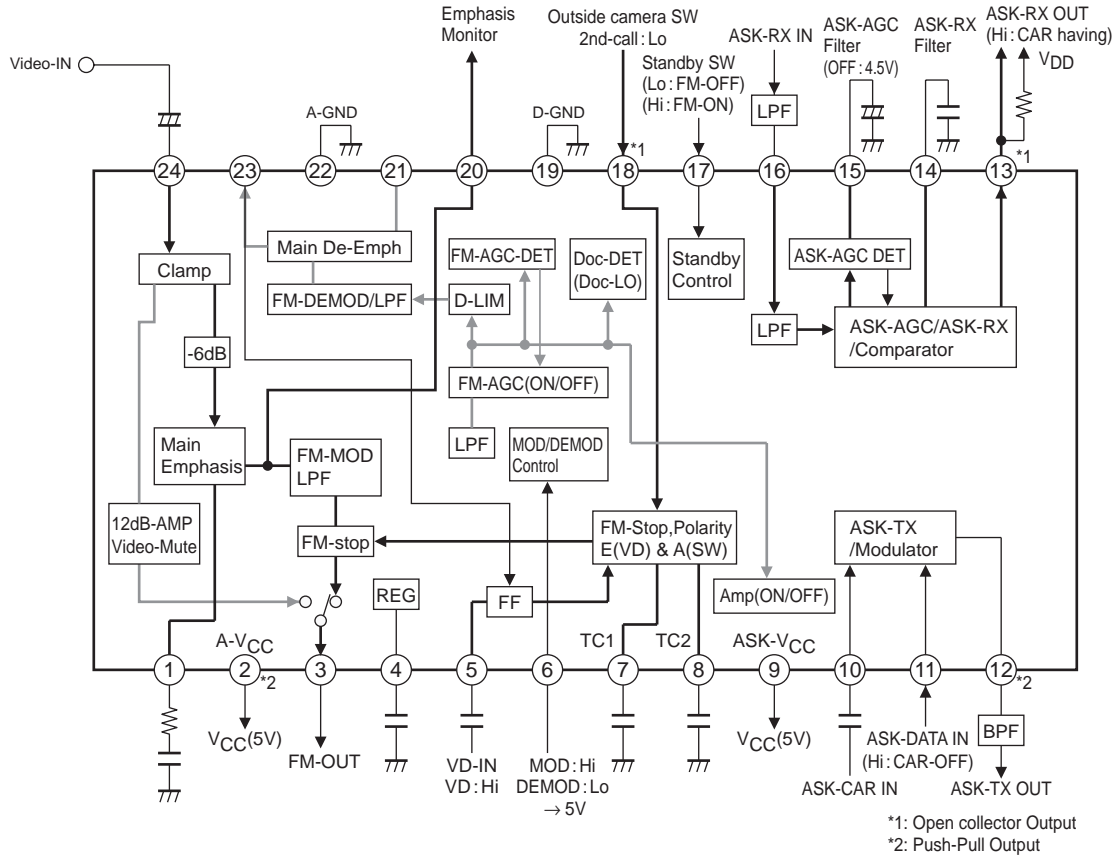
Pin Assignment



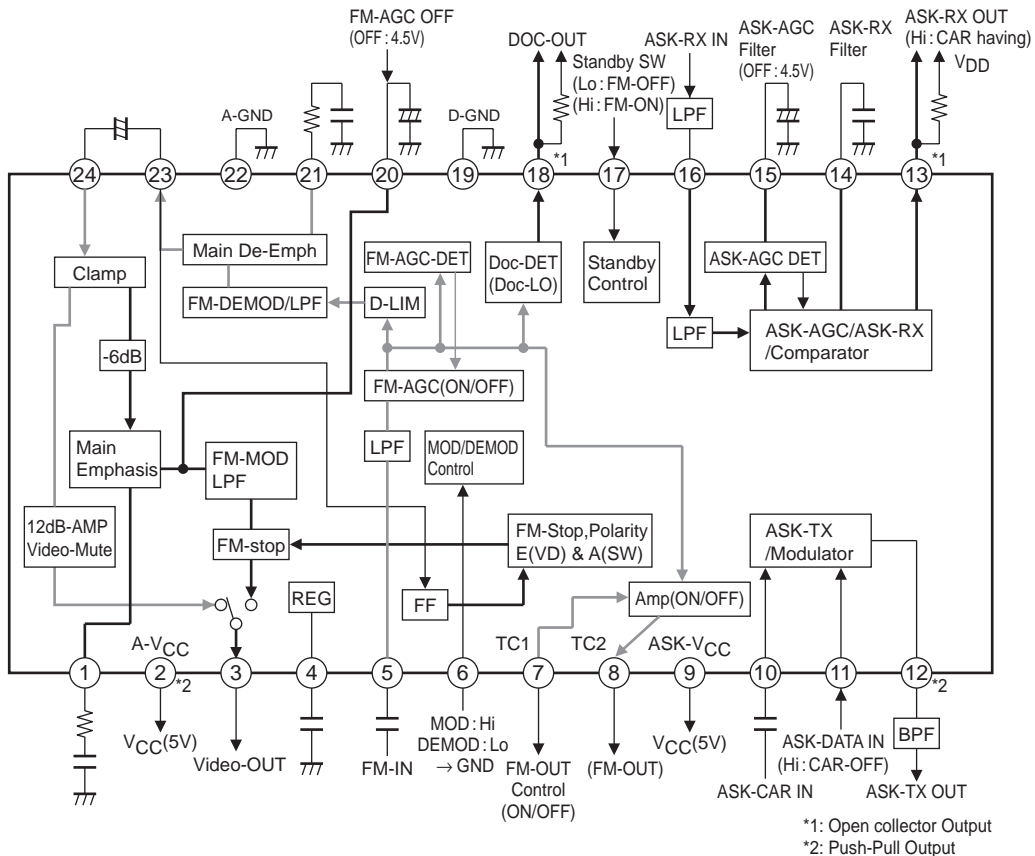
Top view

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Block Diagram and Application Circuit Example1 Modulation (Outside camera)



Application Circuit Example2 Demodulation (Inside monitor)



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Pin Function

| Pin No. | Pin name | FM MOD mode(Outside camera) | FM DEMOD mode(Inside Monitor) | Note |
|---------|-------------------------------------|--|---|---|
| 1 | Emphasis filter | Emphasis filter connection pin | Non connect(Hi-Z) | If you no need, this pin is open. |
| 2 | V _{CC} 5V | V _{CC} for FM modulation. | V _{CC} for FM demodulation. | |
| 3 | FM/Video Output | FM Output (R _O =200Ω:1.8Vp-p) | Video Output (R _O =1kΩ: 2Vp-p) | Push-pull output |
| 4 | 4V Regulator | FM modulate block and ASK bock supply reference voltage. | FM demodulate block and ASK bock supply reference voltage. | |
| 5 | FM/VD input | VD Input. (Hi: over 2V, Low: under 0.4V) (VD DET: High) | FM Input. (Recommend Level: 100 to 620mVp-p) | DEMODO mode: Set 3.3V by internal bias. (34kΩ/66kΩ) |
| 6 | MOD/DEMODO Control | Set over 2V DC voltage. | Set under 0.4V DC voltage. | Outside camera / Inside monitor setting. |
| 7 | TC1(MOD)/ FMAGC monitor Out control | Set capacitor for TC1 | FMAGC monitor out control GND: Monitor ON / V _{CC} : Monitor OFF | Can do second inside monitor addition |
| 8 | TC2(DEMODO)/ FMAGC monitor Output | Set capacitor for TC2 | FMAGC monitor output | Can do second inside monitor addition |
| 9 | ASK-V _{CC} 5V | V _{CC} for ASK | ← | |
| 10 | ASK CAR IN | ASK carrier Input. (Recommend below 3Vp-p) | ← | 2.1V by internal bias. (50kΩ) |
| 11 | ASK DATA IN | ASK Data Input. (Hi: more than 2V, Lo: below 0.4V) | ← | |
| 12 | ASK TX Output | ASK modulated signal Output | ← | Push-pull output |
| 13 | ASK RX Output | ASK Demodulated Output | ← | Open collector output ASK carrier detect = Lo |
| 14 | ASK DET filter | ASK Detector filter | ← | |
| 15 | ASK AGC filter /AGC OFF | AGC filter for ASK. (When AGC operate voltage is 0V to 3V, AGC stop when you add over 4.5V.) | ← | |
| 16 | ASK RX input | ASK Demodulate Input | ← | 3.3V by internal bias. (34kΩ/66kΩ) |
| 17 | Standby control | FM blocks standby control. (FM block operate: over 2V, FM block standby: under 0.4V) | ← | |
| 18 | DOC-OUT /2nd-Call input | 2ND-Call input, 2ND-Call: Low (High: over 2V, Low: under 0.4V) | DOC output (When DO-DET, output is Low) | DEMODO mode: Open collector output. |
| 19 | B-GND | Circuit GND | ← | |
| 20 | FM AGC filter | Emphasis monitor output | FM AGC control filter (AGC-ON:0 to 3V DC, AGC-OFF:4.5V to 5V by external DC voltage.) | MOD mode: Don't connect capacitor. |
| 21 | De-emphasis filter | Non connect(Hi-Z) | De-emphasis filter connection pin. | If you don't need, this pin is open. |
| 22 | A-GND | Circuit GND | ← | |
| 23 | De-emphasis output /V-2V select | DFF for V-diff control (ON: over 2V, OFF: under 0.4V) | DE-emphasis output | MOD mode; VD diff. Count select 0V : VD through 2V : VD 1/2 diff |
| 24 | Video input | Video signal input. (from outside CCD camera: 1Vp-p). | Video signal input. (from de-emphasis block: 0.5Vp-p). | MOD mode: Maximum video input level is 1.5Vp-p. |

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Pin Description

| Pin No. | Pin Name | Description | Equivalent circuit |
|---------|---------------------------------------|--|--------------------|
| 1 | Emphasis filter | Main Emphasis filter pin. Before FM Modulation, make emphasis characteristic at video signal. Emphasis time constant must be matching at de-emphasis time constant. (If you don't need the emphasis, this pin is open.) | |
| 2 | V _{CC} 5V | V _{CC} pin. Supply voltage is 5V DC. Please connect de-coupling capacitor. | |
| 3 | FM/Video OUT | Push-Pull output pin. MOD mode: FM carrier output. (1.8Vp-p: R _{out} =200Ω) DEMOD mode: Video signal output. (2.0Vp-p: R _{out} =1kΩ) | |
| 4 | Regulator filter | Internal regulator filter pin. Please connect 0.1μF (C1). | |
| 5 | FM/VD input | DEMOD mode: FM signal input. Internal DC bias is 3.3V. Please use capacitor (C1) coupling. MOD mode: VD signal input. Please input VD signal directory. Please consider input impedance. | |
| 6 | MOD/DEMOM Control | MOD mode / DEMOD mode setting pin. MOD mode: Please set over 2V DC voltage. (2 to 5V). DEMOM mode: Please set under 0.4V DC voltage. (0 to 0.4V). | |
| 7 | TC1(MOD)/ FMAGC monitor Control | MOD mode: TC1 filter pin. Please connect C1. DEMOM mode: FM-AGC monitor on/off control. GND: AGC-monitor ON V _{CC} : AGC-monitor OFF | |

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| Pin No. | Pin Name | Description | Equivalent circuit |
|---------|--|---|--------------------|
| 8 | TC2(DEMOD)/ FMAGC monitor Output | MOD mode: TC2 filter pin. Please connect C1. DEMOD mode: FM-AGC-monitor output | |
| 9 | ASK- V_{CC5V} | ASK block V_{CC} . Please supply DC 5V with use capacitor for de-coupling. | |
| 10 | ASK CAR IN | ASK carrier input Pin. Please connect with capacitor, 2.1V by internal biased. | |
| 11 | ASK DATA IN | ASK data input pin. L level is lower than 0.4V H level is more than 2V | |
| 12 | ASK TX Output | ASK output pin. Push-pull type output. | |
| 13 | ASK RX Output | ASK detect output. Open corrector type output. | |
| 14 | ASK DET filter | ASK detect filter. Connect capacitor for reject of ASK AC component. | |

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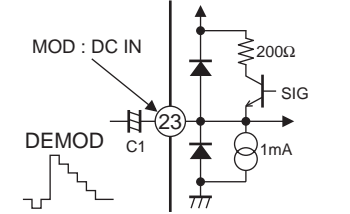
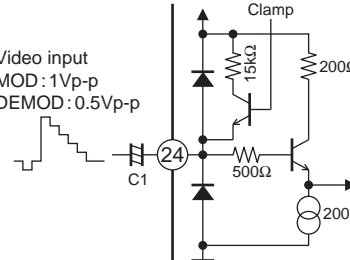
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| Pin No. | Pin Name | Description | Equivalent circuit |
|---------|----------------------------|---|--------------------|
| 15 | ASK AGC filter /AGC OFF | AGC filter pin for ASK. Please connect pull-up resistance to this pin, and do more than 4.5V at voltage of this pin. | |
| 16 | ASK RX input | ASK input pin. Please connect with capacitor, 3.3V by internal biased. | |
| 17 | Standby control | Standby control pin. FM block standby: under 0.4V DC voltage. (0 to 0.4V) FM block operate: over 2V DC voltage. (2 to 5V) | |
| 18 | DOC-OUT /2nd-Call input | DEMODO mode: Drop-out output pin. This pin is open collector output, so please connect pull up resistor. MOD mode: 2ND-CALL input. 2ND-CALL input: under 0.4V DC voltage. (0 to 0.4V) Normal: over 2V DC voltage. (2 to 5V) | |
| 19 | B-GND | Circuit GND. | |
| 20 | FM AGC filter | MOD mode: Emphasis monitor pin. DEMODO mode: FM AGC filter pin. If FM AGC no need (= AGC Off), Please set pin 12 voltage over 4.5V DC voltage. (4.5 to 5V) | |
| 21 | De-emphasis filter | DEMODO mode: De-emphasis filter pin. De-emphasis time constant must be matching at emphasis time constant. (If you don't need the emphasis, this pin is open.) | |
| 22 | A-GND | Circuit GND. | |

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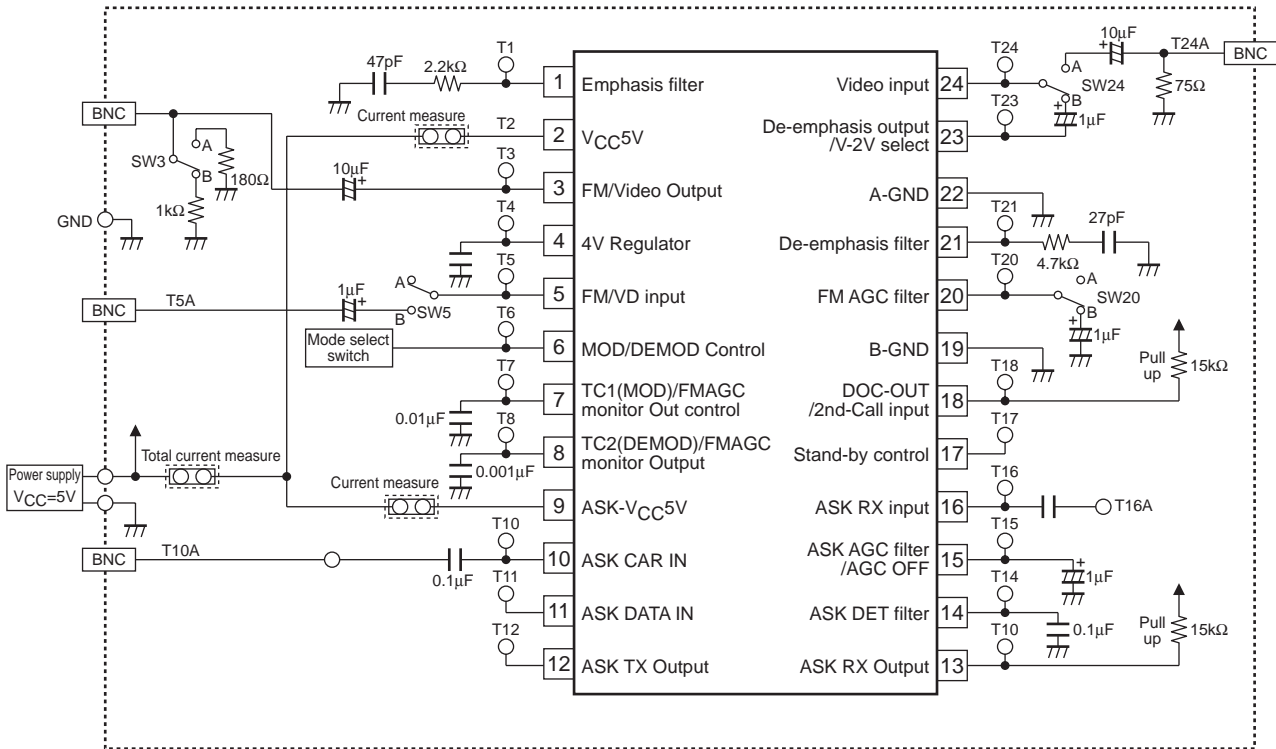
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| Pin No. | Pin Name | Description | Equivalent circuit |
|---------|--|---|---|
| 23 | De-emphasis output <i>V-2V select</i> | DEMOD mode: Video signal output after De-emphasis. Output level is 0.5Vp-p. Connect capacitor to clamp input (pin 16). MOD mode: DFF control pin. DFF is ON at over 2V DC voltage. (2 to 5V) |  |
| 24 | Video input | MOD mode: Video signal input pin (from camera). Input level is 1Vp-p. DEMOD mode: Video signal input pin (from de-emphasis). Input level is 0.5Vp-p. |  |

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Test Circuit



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