

0.73W/CH STEREO CLASS-D AUDIO POWER AMPLIFIER

GENERAL DESCRIPTION

The TMPA2156D2 is a STEREO class-D audio power amplifier IC. With SE(Single-Ended) configuration, it delivers up to 0.73W/CH power into a 3 ohms load or 0.6W/CH power into a 4 ohm load or 0.33W/CH power into an 8 ohm load. No external heat-sink is required.

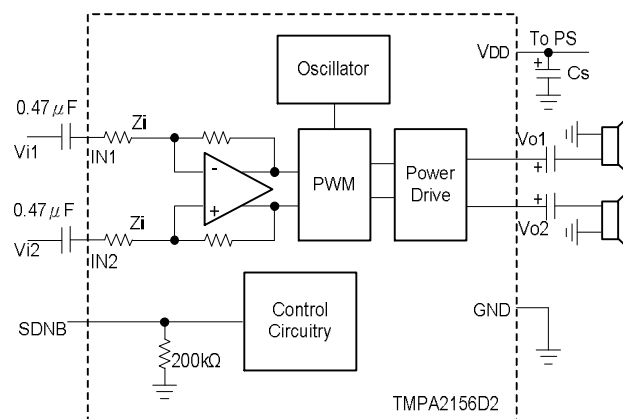
For multiple-input applications, independent gain control and corner frequency can be implemented by summing the input sources through resistor ratio and input capacitor values. Automatic voltage gain control makes the best use of battery.

Analog input signal is converted into digital output which drives directly to the speaker. High power efficiency is achieved due to digital output at the load. The audio information is embedded in PWM (Pulse Width Modulation) .

APPLICATIONS

Multimedia application includes Cellular Phones, PDAs, 2.1 channel, USB audio. It is also ideal for other portable devices like Wireless Radios.

REFERENCE CIRCUIT



FEATURES

- ◆ 2.5V to 6V Single Supply
- ◆ Up to 0.73W/CH at 5V, 3 ohms
- ◆ Up to 85% Power Efficiency
- ◆ Automatic output power control (APC)
- ◆ 2.2mA Quiescent Current at 5V
- ◆ Less Than 0.2uA Shutdown Current
- ◆ Popless Power-Up, Shutdown and Recovery
- ◆ Single-Ended output
- ◆ Thermal Shutoff and Automatic Recovery
- ◆ Short-Circuit Protection
- ◆

Package

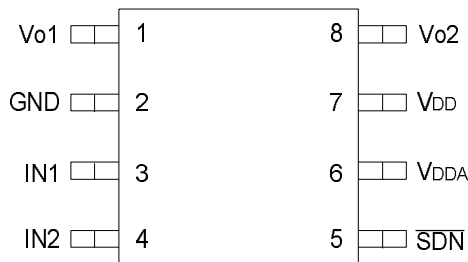
TSSOP8, SOP8 Available

For best performance, please refer to

[//www.taimec.com.tw/data/Tmpa2155EVM/tmpa2156d2EVM.pdf](http://www.taimec.com.tw/data/Tmpa2155EVM/tmpa2156d2EVM.pdf)

for PCB layout.

TOP VIEW

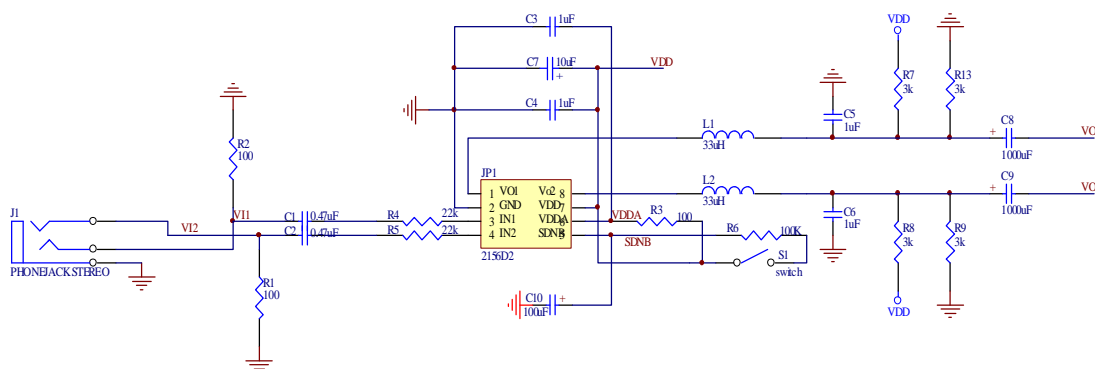


(Please email david@taimec.com.tw for complete datasheet.)

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Note that the external components or PCB layout should be designed not to generate abnormal voltages to the chip to prevent from latch up which may cause damage to the device.

Typical Application



ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range unless otherwise noted(1)

| | | | |
|--|------------------|---------------------------------|----|
| Supply voltage, V _{DD} | In normal mode | -0.3V to 6V | V |
| | In shutdown mode | -0.3V to 7V | V |
| Input voltage, V _I | | -0.3V to V _{DD} +0.3V | V |
| Continuous total power dissipation | | See package dissipation ratings | |
| Operating free-air temperature, T _A | | -20 to 85 | °C |
| Operating junction temperature, T _J | | -20 to 150 | °C |
| Storage temperature, T _{stg} | | -40 to 150 | °C |

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITONS

| | | MIN | NOM | MAX | UNIT |
|--|------|-----|-----|-----------------|------|
| Supply voltage, V _{DD} | | 2.5 | | 6 | V |
| High-level input voltage, V _{IH} | SDNB | 2 | | V _{DD} | V |
| Low-level input voltage, V _{IL} | SDNB | 0 | | 0.8 | V |
| Operating free-air temperature, T _A | | -20 | | 85 | °C |

PACKAGE DISSIPATION RATINGS

| PACKAGE | DERATING FACTOR | T _A ≤ 25 °C POWER RATING | T _A = 70 °C POWER RATING | T _A = 85 °C POWER RATING |
|---------|-----------------|--|--|--|
| SOP8 | 6.39mW/°C | 0.799W | 0.511W | 0.415W |

ELECTRICAL CHARACTERISTICST_A=25 °C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------------|---------------------------------|--|-----|-----|-----|------|
| PSRR | Power supply rejection ratio | V _{DD} =V _{DDA} =2.5V to 5.5V | | -75 | -55 | dB |
| CMRR | Common mode rejection ratio | V _{DD} =V _{DDA} =2.5V to 5.5V, V _{IC} =1V _{pp} , R _L =8Ω | | -55 | -50 | dB |
| I _{IH} | High-level input current | V _{DD} =V _{DDA} =5.5V, V _I =5.8V (SDNB) | | 30 | | μA |
| I _{IL} | Low-level input current | V _{DD} =V _{DDA} =5.5V, V _I =-0.3V (SDNB) | | | 1 | μA |
| I _Q | Quiescent current | V _{DD} =V _{DDA} =5V, no load | | 2.2 | 3 | mA |
| I _Q (SD) | Shutdown current | V(SDNB)=0.8V, V _{DD} =V _{DDA} =2.5V to 5.5V | | 0.2 | 0.5 | μA |
| r _{DS(on)} | Static output resistance | V _{DD} =V _{DDA} =5.5V | | 600 | | mΩ |
| f(sw) | Switching frequency | V _{DD} =V _{DDA} =2.5V to 5.5V | 200 | 250 | 300 | kHz |
| *A _v | Voltage gain | V _{DD} =V _{DDA} =2.5V to 5.5V, R _L =8Ω | 17 | 21 | 25 | V/V |
| R _{SDN} | Resistance from shutdown to GND | V(SDNB)=5V | | 200 | | kΩ |
| Z _I | Input impedance | | 12 | 15 | 18 | kΩ |

*The gain of the amplifier is determined by, for V_{DD}=V_{DDA}=2.5V to 5.5V

$$\text{Gain} = \frac{320\text{kohms}}{R_i + 15\text{kohms}} \quad \text{where } R_i \text{ is the external serial resistance at the input pin.}$$

OPERATING CHARACTERISTICS

$T_A=25\text{ }^\circ\text{C}$, $R_L=8\Omega$ speaker (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------|--------------------------------------|---|---|------|-----|------|
| Po | Output power/CH | $R_L=8\Omega$ | | 0.33 | | W |
| | | $R_L=4\Omega$ | $V_{DD}=V_{DDA}=5V$. THD+N=10%, f=1kHz. | 0.6 | | |
| | | $R_L=3\Omega$ | | 0.73 | | |
| THD+N | Total harmonic distortion plus noise | $V_{DD}=V_{DDA}=5V$, $P_O=0.2W$, $R_L=8\Omega$, f=1kHz | | 0.55 | | % |
| | | $V_{DD}=V_{DDA}=5V$, $P_O=0.3W$, $R_L=4\Omega$, f=1kHz | | 0.55 | | |
| | | $V_{DD}=V_{DDA}=5V$, $P_O=0.4W$, $R_L=3\Omega$, f=1kHz | | 0.64 | | |
| SNR | Signal-to-noise ratio | $V_{DD}=V_{DDA}=5V$, $P_O=1W$, $R_L=8\Omega$ | | 85 | | dB |
| Crosstalk | Crosstalk between outputs | $V_{DD}=AV_{DD}=5V$, $P_O=1W$ $R_L=8\Omega$ | | -60 | | dB |

TERMINAL FUNCTIONS

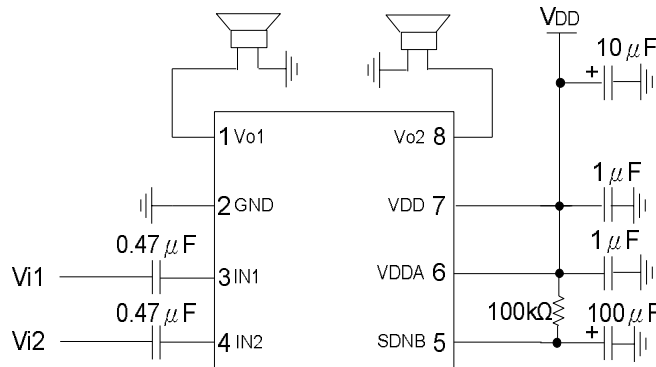
| TERMINAL | | I/O | DESCRIPTION |
|----------|--------|-----|-----------------------------|
| NAME | PIN NO | | |
| GND | 2 | I | Digital ground |
| IN2 | 4 | I | Channel 2 input |
| IN1 | 3 | I | Channel 1 input |
| SDNB | 5 | I | Shutdown (active low logic) |
| VDD | 7 | I | Digital Power supply |
| VDDA | 6 | I | Analog Power supply |
| Vo1 | 1 | O | Channel 1 output |
| Vo2 | 8 | O | Channel 2 output |

TYPICAL CHARACTERISTICS

Note 1. Input coupling $1\mu\text{F}$ capacitors are used for all measurements.

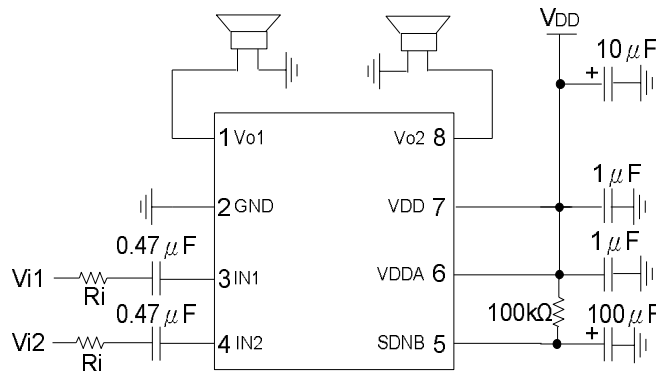
- LC filter is used for THD+N measurement and power efficiency measurement.
- Characteristic frequency of the LC filter is set 41KHz unless otherwise specified.

APPLICATION INFORMATION



Suppose source impedance of the input is relatively smaller than Ri

Figure.1 Gain of each channel = $\frac{320k}{15k} = 21$



Suppose source impedance of the input is relatively smaller than Ri

Figure.2 Gain of each channel = $\frac{320k}{15k+Ri}$

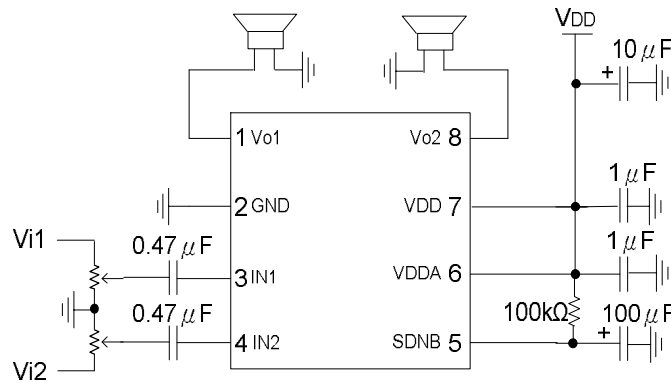


Figure.3 With Gain Control

I Input Resistors and Gain

The gain of the amplifier is determined by, for VDD=VDDA =2.5V to 5.5V

$$\text{Gain} = \frac{320\text{kohms}}{R_i + 15\text{kohms}} \quad \text{where } R_i \text{ is the external serial resistance at the input pin.}$$

Note : Please refer to document 010 APP for more application examples.

DETAILED DESCRIPTION

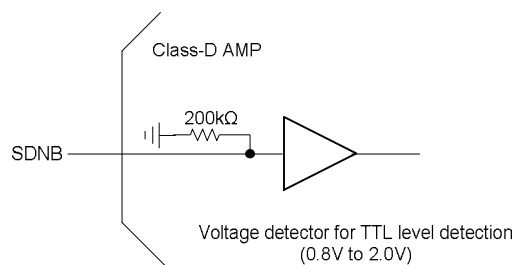
Efficiency

The output transistors of a class D amplifier act as switches. The power loss is mainly due to the turn on resistance of the output transistors when driving current to the load. As the turn on resistance is so small that the power loss is small and the power efficiency is high. With 8 ohm load the power efficiency can be better than 85%.

Shutdown

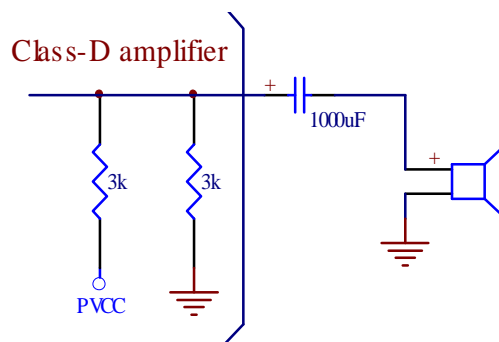
The shutdown mode reduces power consumption. A LOW at shutdown pin forces the device in shutdown mode and a HIGH forces the device in normal operating mode. Shutdown mode is useful for power saving when not in use. This function is useful when other devices like earphone amplifier on the same PCB are used but class D amplifier is not necessary.

Internal circuit for shutdown is shown below.



Pop-less

The setup time for the internal circuitry to be stable to drive the speaker is quite fast (<100ms). But for Single-ended outputs the set up time for the output circuit to charge up the output coupling capacitor (=1000uF) to half power voltage is quite long. As shown in the following diagram, the RC constant caused by the voltage divider of equivalent resistance of 1.5k ohms(3kohms//3kohms) and the capacitance of 1000uF of the output coupling capacitor is 1.5 seconds. So to save pop noise the shutdown pin(SDNB) has to be LOW during power up. In addition the shutdown pin has to stay LOW for about 5 seconds to wait for the output coupling capacitor to be charged to half supply voltage.



Voltage gain

The voltage gain is defined in the table on page 3. For lower voltage gain one can add external input resistors to input pins.

Automatic output Power Control (APC)

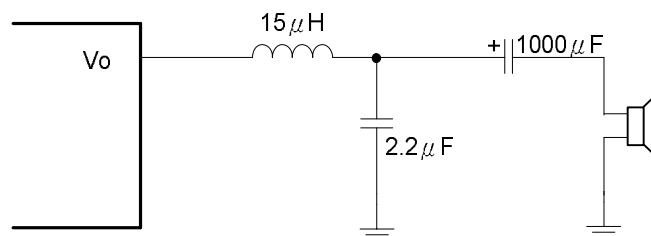
The voltage gain is self adjusted in the chip over voltage range. This means that, regardless supply voltage change, the output power keeps about the same for a given input level from $V_{DD}=5.5v$ to $2.5v$. It allows the best use of the battery.

Output filter

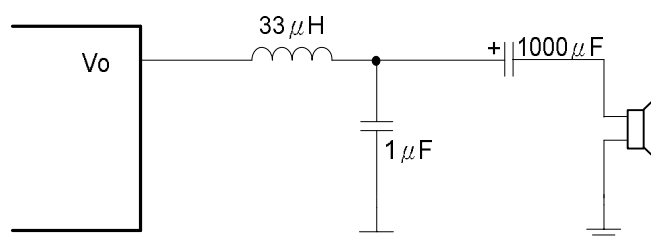
Ferrite bead filter can be used for EMI purpose. The ferrite filter reduces EMI around 1 MHz and higher (FCC and CE only test radiated emissions greater than 30 MHz). When selecting a ferrite bead, choose one with high impedance at high frequencies, but low impedance at low frequencies.

Use an LC output filter if there are low frequency (< 1 MHz) EMI sensitive circuits and/or there are long wires from the amplifier to the speaker. EMI is also affected by PCB layout and the placement of the surrounding components.

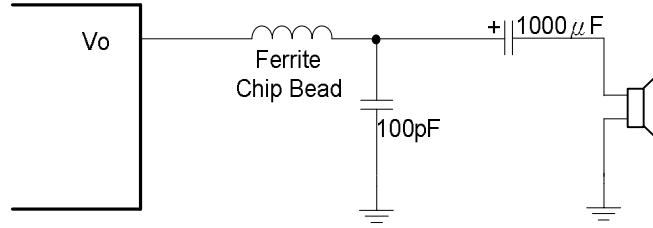
The suggested LC values for different speaker impedance are showed in following figures for reference.



Typical LC Output Filter, Speaker Impedance= 4Ω



Typical LC Output Filter, Speaker Impedance= 6Ω & 8Ω

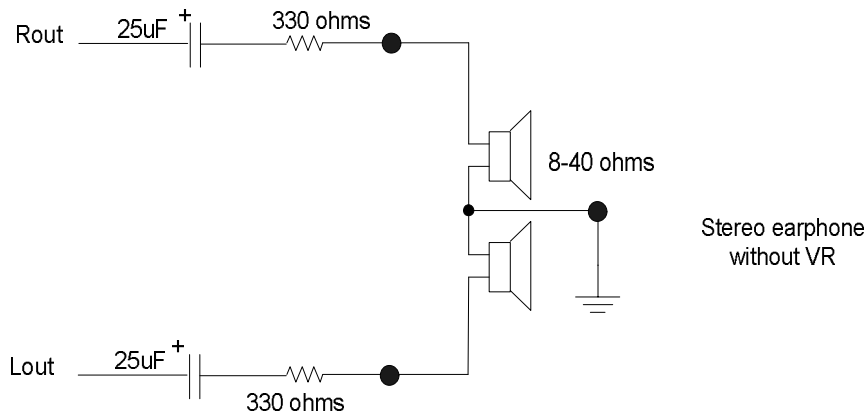
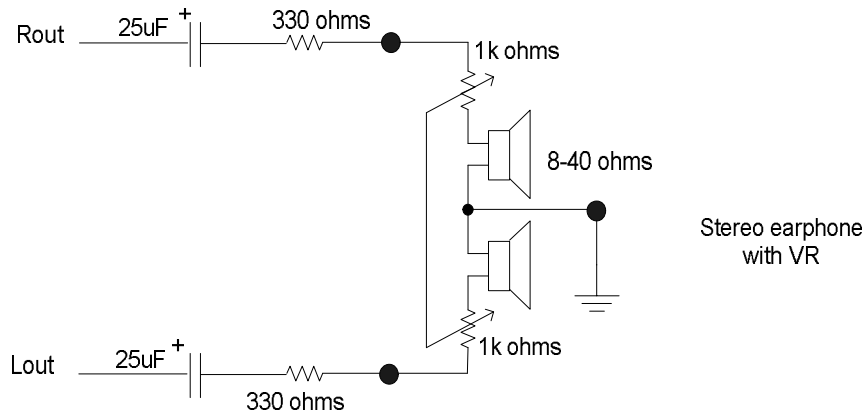


Typical Ferrite Chip Bead Filter

(Chip bead example : 遠越科技 KML2012Q102N
1kohms@100MHz, DCR=0.2ohms, I=1A)

EARPHONE USE

Class-D output can be used to drive earphone. However to avoid high power to overdrive earphone and to prevent human ear to accidentally be hurt, a resistor has to be put in series with the earphone speaker. Typically a resistor of 330 ohms is adequate for this purpose.



Over temperature protection

A temperature sensor is built in the device to detect the temperature inside the device. When a high temperature around 145oC and above is detected the switching output signals are disabled to protect the device from over temperature. Automatic recovery circuit enables the device to come back to normal operation when the internal temperature of the device is below around 120oC.

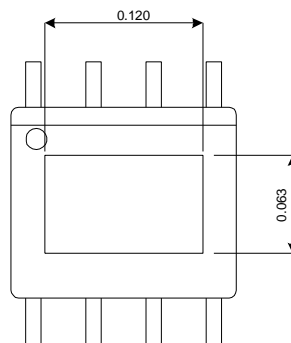
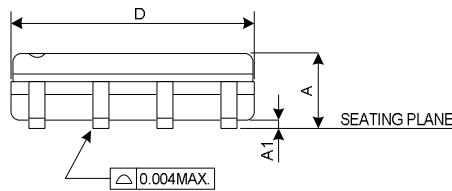
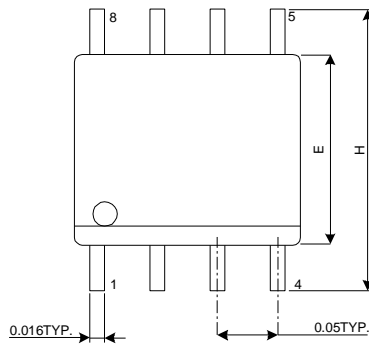
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Over current protection

A current detection circuit is built in the device to detect the switching current of the output stages of the device. It disables the device when the current is beyond about 3.5amps. It protects the device when there is an accident short between outputs or between output and power/gnd pins. It also protects the device when an abnormal low impedance is tied to the output. High current beyond the specification may potentially causes electron migration and permanently damage the device. Shutdown or power down is necessary to resolve the protection situation. There is no automatic recovery from over current protection.

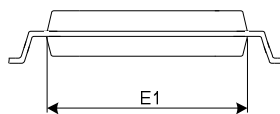
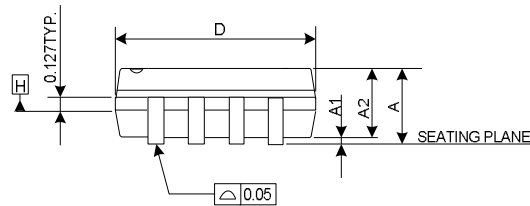
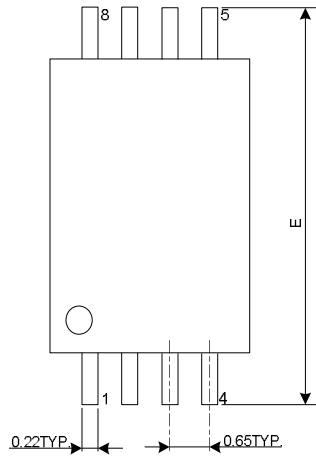
Physical Dimensions (IN MILLIMETERS)



| SYMBOLS | MIN. | MAX. |
|---------|-------|-------|
| A | 0.053 | 0.069 |
| A1 | 0.004 | 0.010 |
| D | 0.189 | 0.196 |
| E | 0.150 | 0.157 |
| H | 0.228 | 0.244 |

SOP8

Physical Dimensions (IN MILLIMETERS)



| SYMBOLS | MIN. | NDM. | MAX. |
|---------|----------|------|------|
| A | - | - | 1.20 |
| A1 | 0.05 | - | 0.15 |
| A2 | 0.96 | 1.01 | 1.06 |
| D | 2.90 | 3.00 | 3.10 |
| E | 6.40 BSC | | |
| E1 | 4.30 | 4.40 | 4.50 |

TSSOP8

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