# AP1511A / B

## IR Filter Switch Driver
## with one-shot output
## for IR-Cut Removable (ICR)

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## FEATURES

- 1.8V input driving pulse
- Low saturation voltage (0.73V@300mA,VDD=5V)
- Low standby current (<10uA)
- 2.5V to 5.5V operating voltage range
- 6-lead SOT-26 package
- Only one control input and Built-in non-overlap circuit to avoid the MOSFET damage caused by the fast output voltage transient

## APPLICATIONS

- IR filter switch driver for IR-Cut Removable (ICR) of IP CAM.

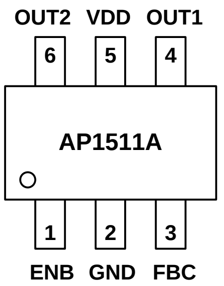
## DESCRIPTION

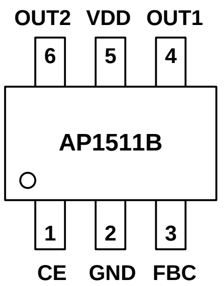
AP1511 is an IR filter switch driver IC designed for switching IR filter in IR-Cut Removable (ICR) of IP CAM. With appropriate input controls, AP1511 functions as a one-channel, low saturation, bi-directional H-bridge driver. Built-in protection diode circuit can minimize the disturbance caused by the feedback current when the ICR is shut down, or when ESD impulse occurs.

The typical impedance of the current switches in AP1511 shown in Fig. 1 is less than 3 ohms. The current driven through the actuator is then determined by the impedance of the ICR. For example, with 5.0V power supply, the current through the actuator is around 300mA with 0.73V output voltage drop.

Two types of AP1511 (Ver. A & Ver. B) are offered to support single-wire control, dual-wire control and single-wire one-shot control modes as shown in Fig. 1 and Fig. 2.

## PIN CONFIGURATION




| Pin # | Mnemonic | I/O | Description |
|---|---|---|---|
| 1 | ENB | I | Low-active enable |
| | CE | I | External capacitor |
| 2 | GND | - | Ground |
| 3 | FBC | I | Forward/Backward control |
| 4 | OUT1 | O | Driver output 1 |
| 5 | VDD | - | Power supply |
| 6 | OUT2 | O | Driver output 2 |

## ORDERING INFORMATION

| MODEL | PACKAGE |
|---|---|
| AP1511A | SOT-26 |
| AP1511B | SOT-26 |

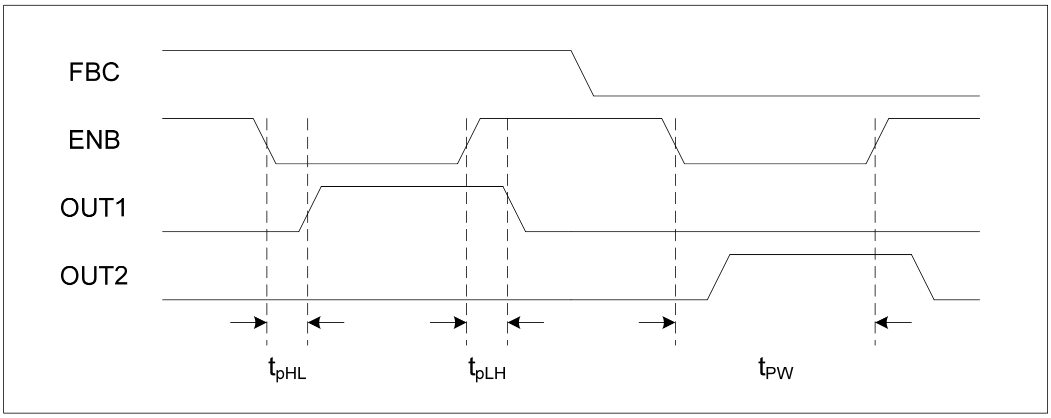
## Absolute Maximum Ratings (unless otherwise specified, Temperature=25℃)

| Characteristic | Symbol | Rating | Unit |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | 5.5 | V |
| Input Voltage | $V_{IN}$ | $V_{DD}$+0.4V | V |
| Output Current | $I_{OUT}$ | 500 | mA |
| Operating Temperature Range | $T_{OPR}$ | -40~125 | ℃ |
| Storage Temperature Range | $T_{STO}$ | -65~150 | ℃ |

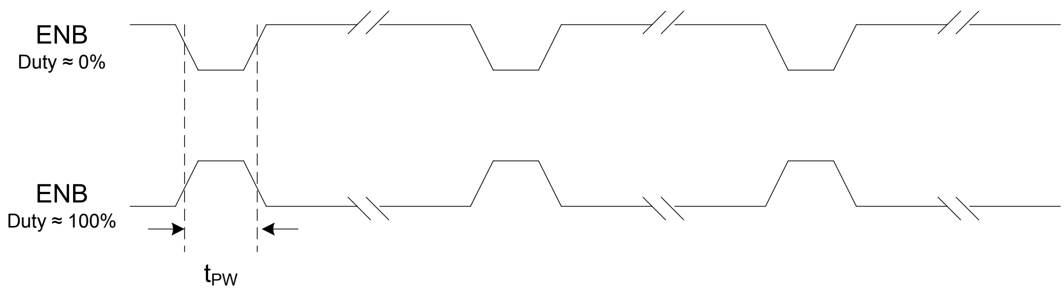
## Electrical Characteristics (unless otherwise specified, Temperature=25℃ & $V_{DD}$=5.0V)

| Characteristic | Sym. | Condition | Limit Min. | Limit Typ. | Limit Max. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | - | 2.5 | 5.0 | 5.5 | V |
| Supply Current | $I_{STB(A)}$ | Steady state or standby state version A | - | - | 20 | μA |
| | $I_{STB(B)}$ | Steady state or standby state version B | - | - | 10 | μA |
| | $I_{DD}$ | Transit state | 0.8 | 1 | 1.2 | mA |
| **Driver input control ENB/FBC** | | | | | | |
| Input High “H” | $V_{IH}$ | - | 1.6 | - | $V_{DD}$+0.4 | V |
| Input High “L” | $V_{IL}$ | - | -0.4 | - | 0.2*$V_{DD}$ | V |
| **Driver output OUT1/OUT2** | | | | | | |
| Output Voltage (upper + lower) | $V_{OUT1}$ | $I_{OUT}$ = 200 mA | - | 0.42 | - | V |
| | $V_{OUT2}$ | $I_{OUT}$ = 300 mA | - | 0.73 | - | V |
| | $V_{OUT3}$ | $I_{OUT}$ = 400 mA | - | 1.03 | - | V |
| Rise transition time | $T_R$ | From 0.1*VDD to 0.9*VDD | - | 2.5 | 5 | ns |
| Fall transition time | $T_F$ | From 0.9*VDD to 0.1*VDD | - | 3.5 | 7 | ns |

| Characteristic | Sym. | Condition | Limit | | | Unit |
|---|---|---|---|---|---|---|
| **Propagation Delay Time** | | | | | | |
| ENB → OUT1 / 2 ( "L" to "H" ) | $t_{pLH}$ | VDD = 5V, Load = 18Ω | - | 13 | 16 | ns |
| ENB → OUT1 / 2 ( "H" to "L" ) | $t_{pHL}$ | | - | 36 | 43 | ns |
| Pulse Width of ENB | $t_{PW}$ | | 100 | - | - | ns |
| Maximum frequency of ENB | $f_{MAX}$ | | - | - | 5 | MHz |

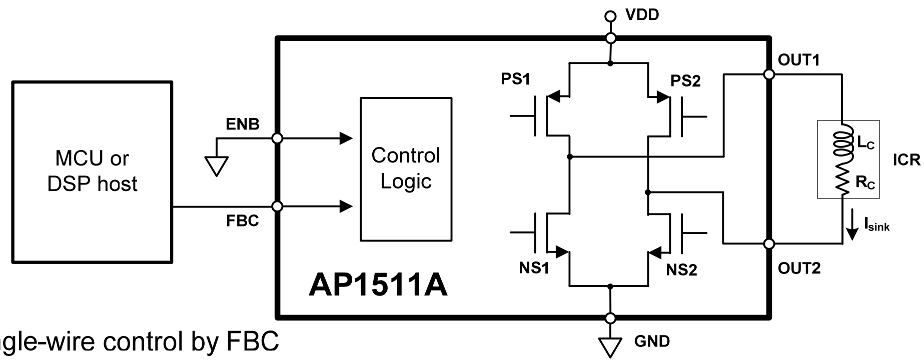



Propagation delay time between ENB and OUT1/2

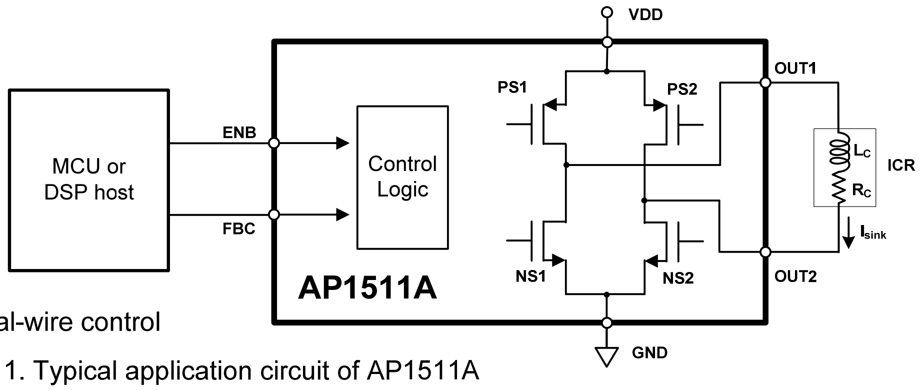



PWM waveform for ENB

## Typical Application ( AP1511A )




(a) Single-wire control by FBC

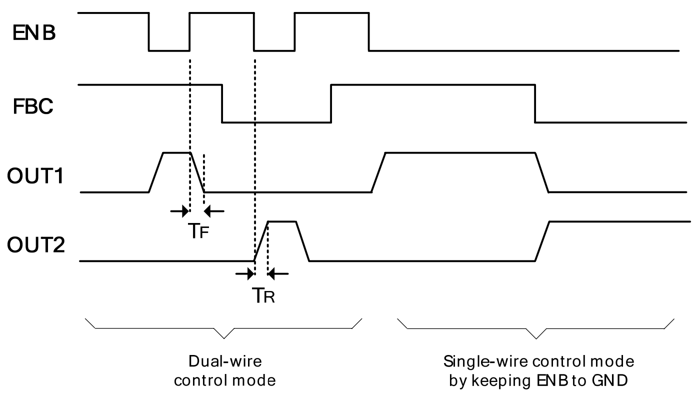



(b) Dual-wire control

Figure 1. Typical application circuit of AP1511A

## Truth Table and Diagram of Controls

| Input | | Output | |
|---|---|---|---|
| ENB | FBC | OUT1 | OUT2 |
| H | X | L | L |
| L | H | H | L |
| L | L | L | H |



## Typical Application ( AP1511B )

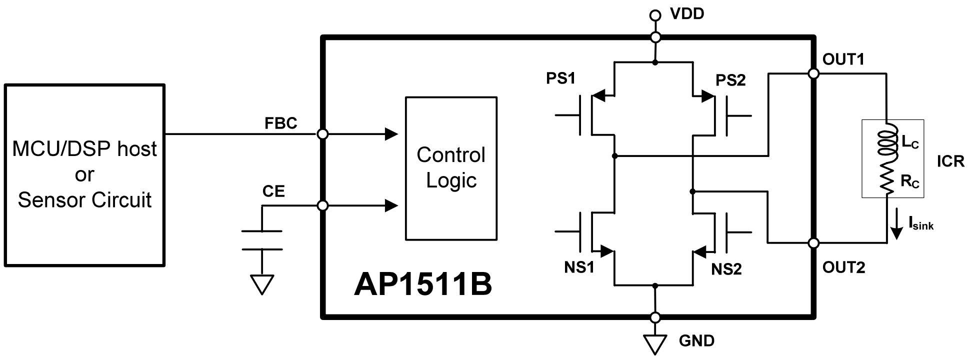
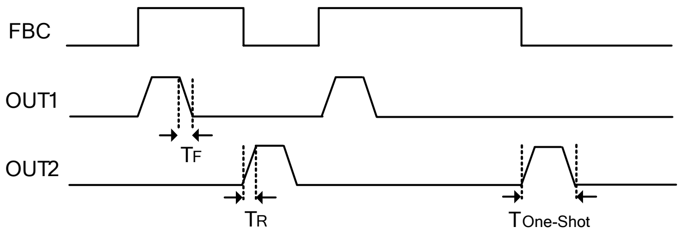



Figure 2. Typical application circuit of AP1511B

## Truth Table and Diagram of Controls

| Input | Output | |
|---|---|---|
| FBC | OUT1 | OUT2 |
| _\|‾ | _/‾_ | ___ |
| ‾\|_ | ___ | _/‾_ |

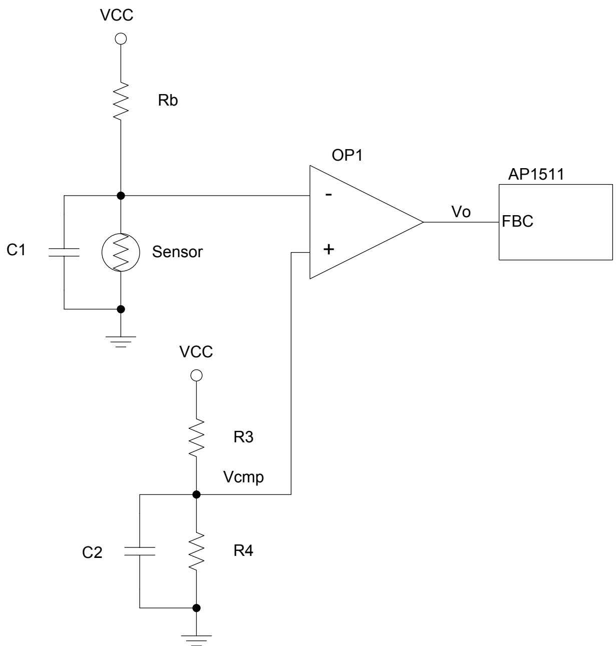



The period of $T_{One\text{-}Shot}$ is determined by the external capacitor connected on CE pin. It can be estimated from the equation.

$T_{one\text{-}Shot} = 1.3 \times 10^{6} \times C_{CE}$ ( second )

The time of one-shot would decrease 0.2 %/℃ by temperature increase with the constant capacitance of $C_{CE}$. In fact, the capacitance of a real capacitor is affected by temperature change and has its maximum value at 25℃. It is suggested to set the time of one-shot more than twice time that the ICR-module needs.

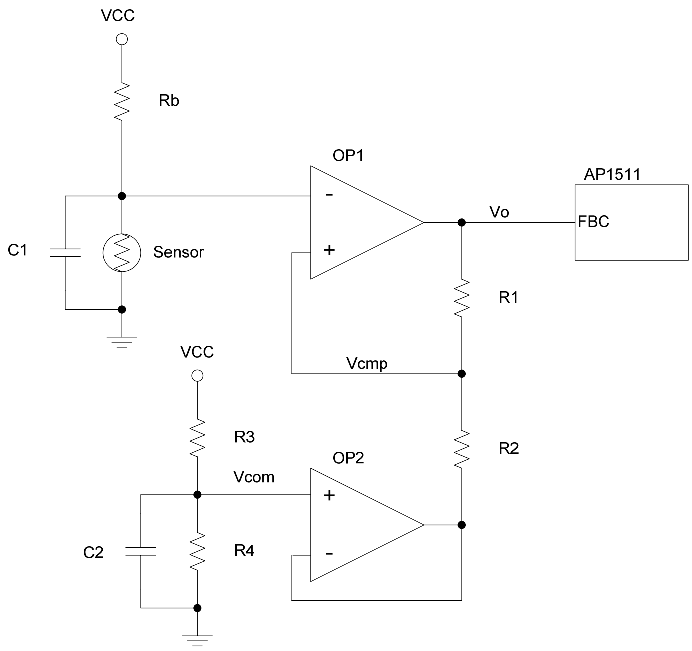
The environment illumination can be detected by a photo sensor that is like CdS photo resistors or photodiodes. By using a comparator to decide day or night to control the direction of the FBC pin of AP1511. Thus the IR lens position of the IR-cut module is according to the environment illumination. But a simple comparator circuit doesn't have any noise tolerance and there is too much glitch single due to the environment influence. A simple comparator circuit for a photo sensor is shown below. The resistor Rb is a bias resistor to generate the bias voltage for the photo sensor. The threshold voltage Vcmp that is decided by the resistors R3 and R4 is compared with the voltage of the photo sensor. The output direction of AP1511 is according to the result of the comparator ( OP1 ).




The circuit is changed from a comparator to a schmitt trigger to solve the low noise tolerance issue. The offset voltage ( Vcom ) is generated by the resistors R3 and R4 and buffered by the buffer ( OP2 ). The threshold voltage ( Vcmp ) can be expressed as

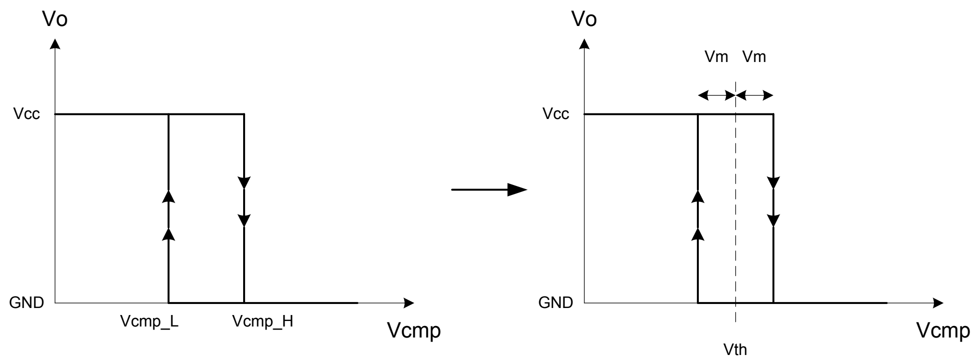
$$Vcmp = \frac{R2}{R1+R2}(Vo - Vcom) + Vcom = \frac{R2}{R1+R2}Vo + \frac{R1}{R1+R2}Vcom$$

Take the LMV358 for example, it is a rail-to-rail output operation amplifier. The output swing of LMV358 can be up to Vcc and down to GND. The high and low threshold voltage are expressed as




$$Vcmp\_H = \frac{R2}{R1+R2}Vcc + \frac{R1}{R1+R2}Vcom \qquad \text{( Vo = Vcc )}$$

$$Vcmp\_L = \frac{R2}{R1+R2}\cdot 0 + \frac{R1}{R1+R2}Vcom = \frac{R1}{R1+R2}Vcom \qquad \text{( Vo = GND )}$$

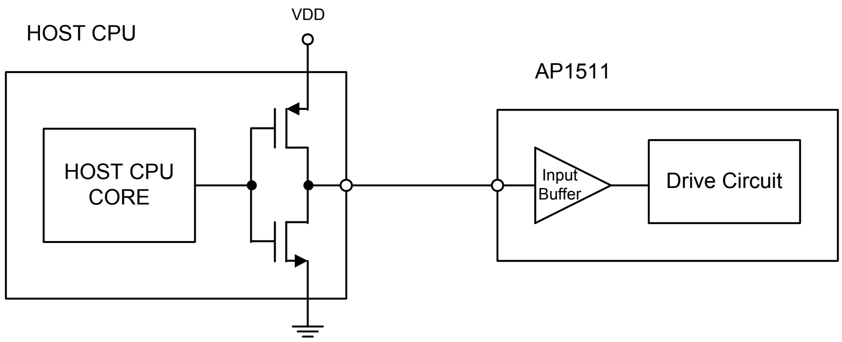



$$Vth = (Vcmp\_H + Vcmp\_L)/2 = \frac{R2}{2(R1+R2)}Vcc + \frac{R1}{R1+R2}Vcom$$

$$Vm = (Vcmp\_H - Vcmp\_L)/2 = \frac{R2}{2(R1+R2)}Vcc$$

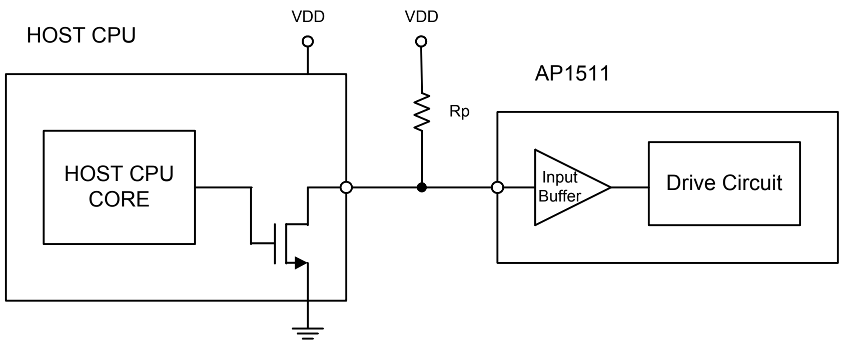
The new threshold voltage Vth and the noise margin Vm are shown above. These voltages can be got by choosing the properly resistance of R1 and R2. The output of the schmitt trigger is changed when the variation of the photo sensor voltage is greater than 2 · Vm. This circuit has a great noise tolerance to avoid the disturbance of the environment influence.

The ENB and FBC pins of AP1511 are the high impedance input pins without pull high resistors. The input voltage of these pins must be great than $V_{IH}$ or small than $V_{IL}$ to ensure the logic states of the input buffers are stable. In most cases, AP1511 is controlled by the GPIO pin of the host CPU. There are two type output buffers, tri-states output and open-drain output.




HOST CPU with tri-state output buffer

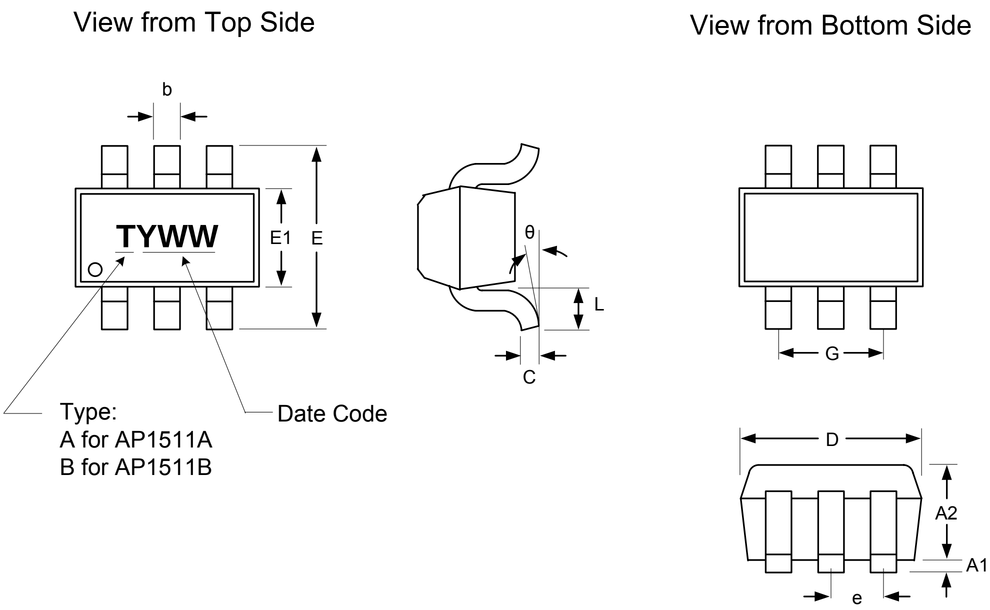
Because the tri-state output buffer can drive output voltage up to VDD and down to GND. The GPIO pin is connected to the ENB or FBC pins of AP1511 directly.




Host CPU with open-drain output buffer

The open-drain output buffer only drives the output voltage low and needs an external pull-high resistor Rp to set up a high logic level voltage when the N-channel MOSFET is turned off. The resistance of the pull high resistor is in the order of hundreds kΩ is acceptable. The smaller resistance will cause the faster rise time of the output buffer, but more current consumption when the N-channel MOSFET is turned on.

## OUTLINE DIMENSION (SOT-26)




| SYMBOLS | DIMENSION (MM) | | | DIMENSION (MIL) | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A1 | 0.02 | 0.05 | 0.1 | 0.80 | 2.00 | 4.00 |
| A2 | 1.00 | 1.10 | 1.30 | 40.0 | 44.0 | 52.0 |
| b | 0.35 | 0.38 | 0.45 | 14.0 | 15.0 | 18.0 |
| C | 0.10 | 0.15 | 0.20 | 4.0 | 6.0 | 8.0 |
| D | 2.90 | 3.00 | 3.10 | 116 | 120 | 124 |
| E | 2.70 | 2.80 | 3.00 | 108 | 112 | 120 |
| E1 | 1.50 | 1.60 | 1.70 | 60.0 | 64.0 | 68.0 |
| e | | 0.95 | | | 38 | |
| G | | 1.90 | | | 76 | |
| L | 0.35 | 0.40 | 0.55 | 14.0 | 16.0 | 22.0 |
| $\theta$ | 0° | 8° | - | 0° | 8° | - |