CAN-FD bit-timing calculator

MHS-Elektronik offers the Bit Timing Calculator (BitCalc) tool for calculating CAN bit-timing register values for microcontrollers from different manufacturers.

The tool supports CAN CC (classic) and CAN FD variants. Tolerances for bit rates can be specified and a list of CAN peripheral clock frequencies can be created. The sample point, synchronization jump width (SJW), and other parameters are configurable. For CAN FD, the time quantum is crucial: the smaller this value is, the better. Using the available peripheral clock frequencies and all specified parameters, including the sample point, BitCalc attempts to determine the optimum values. These are then sorted and output in a tabular form. The tool runs on Windows XP (and later Windows versions) or under Linux using Wine. BitCalc is available for download from the company's website.

The tool supports microcontrollers from the manufacturers as shown in Table 1.

Table 1: Microcontrollers supported by BitCalc (Source: MHS-Elektronik)

Manufacturer	Products / product families
Analog Devices	◆ *BlackFin*
Infineon	◆ *MultiCAN* ◆ *TC21x/TC22x/TC23x family (CAN-FD)* ◆ *FX/FM3 series* ◆ *LX series*
Microchip	◆ *AT90CANxxx, (A)T89C51* ◆ *AT91* ◆ *ATSAM (CAN-FD)* ◆ *dsPICxxF* ◆ *MCP251x* ◆ *MCP251xFD*
NXP	◆ *FlexCAN modules* ◆ *HC05xx, HC08xx, HC12xx (MCAN)* ◆ *S32K1xx (CAN-FD)* ◆ *LPC546xx (CAN-FD)* ◆ *MPC5748G (CAN-FD)* ◆ *SJA1000*
Renesas	◆ *M16C/R8C family* ◆ *M32R family* ◆ *RX6xx* ◆ *RZ family* ◆ *SuperH family*
STMicroelectronics (ST)	◆ *STM32G0, STM32G4, STM32H7, STM32L5, STM32MP1 (CAN-FD)* ◆ *STM32*

Program description

On the start screen of the "Bit Timing Calculator", first select the controller (see "red 1" in Figure 1: "Select by Controller"). The grey-shaded controller setup area is then enabled (see Figure 2). Next, select the manufacturer ("red 2") and series ("red 3"). In our example, the manufacturer is STMicroelectronics (ST) and the series is "STM32G0, STM32G4, …".

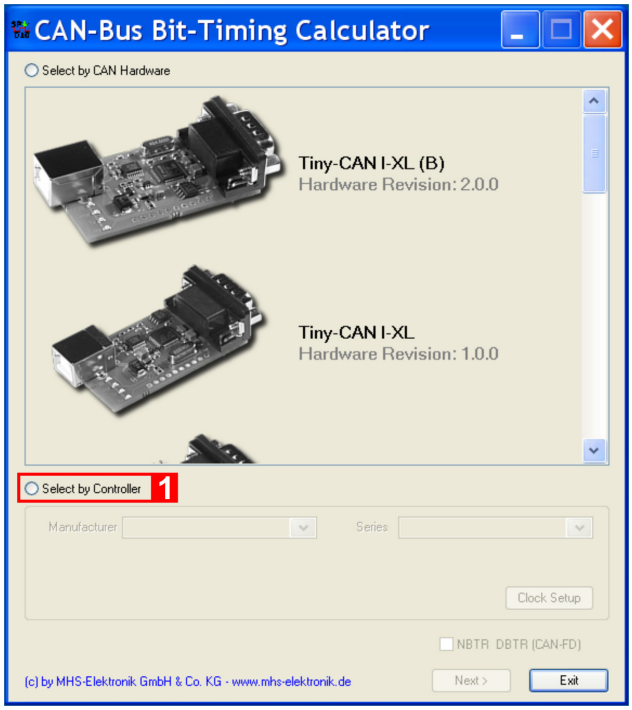

Figure 1: Start screen of the "Bit Timing Calculator" (Source: MHS-Elektronik)

Figure 2: Controller setup area (Source: MHS-Elektronik)

The "red 4" shows the list of CAN peripheral clock frequencies used. Select under "red 5" the "Clock Setup" to change this list. The selected controller series is a CAN ▷

FD controller. At the “red 6” you can disable calculation of the CAN FD data-phase bit rate. Then click “red 7” (“Next”) to configure the bit rates.

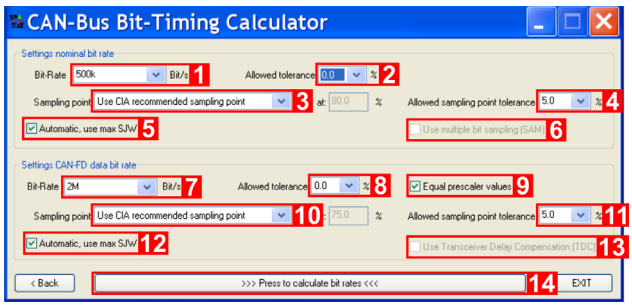

Figure 3: Window for bit-rate calculation (Source: MHS-Elektronik)

Then, the window as shown in Figure 3 is enabled. The standard bit rates are available in the drop-down list (see “red 1”) for CAN CC and the drop-down list (see “red 7”) for CAN FD. To calculate custom CAN CC and CAN FD bit rates, enter the bit rate in the corresponding text box. The prefixes “k” and “M” are supported. Use a decimal point for decimal values. For example, 33.3 kbit/s. The “red 2” (“red 8” for CAN FD) specifies the permitted percentage deviation from the entered bit rate. This value should normally be left at “0.0 %”; specifying a tolerance is only recommended for custom bit rates.

At the “red 3” (“red 10” for CAN FD), select the method used to determine the sample point:

1. Use CiA-recommended sample point
2. Fixed sample point
3. Range

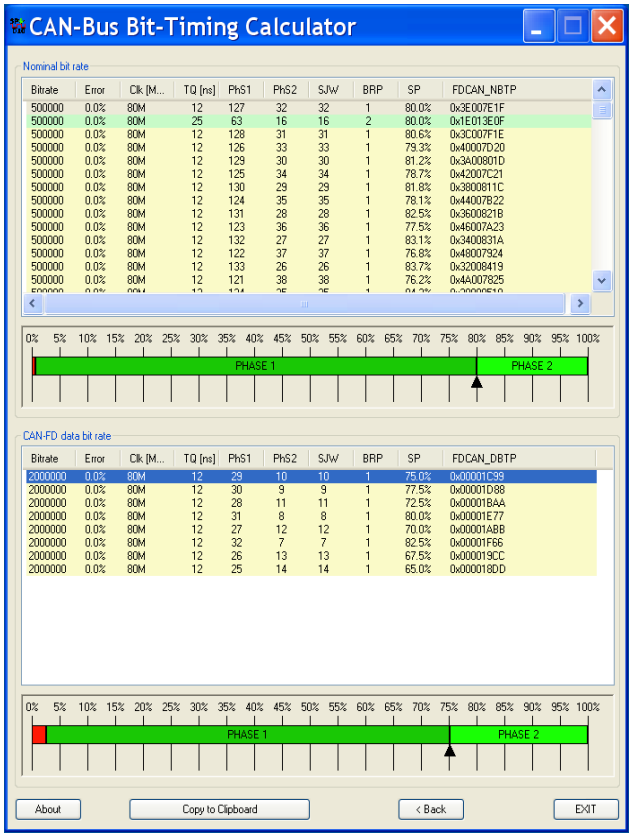

Figure 4: Resulting bit-rate tables (Source: MHS-Elektronik)

For options 1 and 2, a fixed value is specified with a permitted tolerance at “red 4” (“red 11” for CAN FD). When the calculated bit-rate tables are sorted, the values with the smallest tolerance are given priority. For option 3, a permitted range is specified for the sample point. With this setting, the sample point does not affect the sorting order.

When “red 5” (“red 12” for CAN FD) is enabled, the synchronization jump width (SJW) is automatically set to the maximum possible value. When it is disabled, the value is set manually. “Red 6” and “red 13” are features that may or may not be included in the BTRs (bit-timing registers), depending on the controller. Refer to the relevant controller datasheets for further information. At “red 9”, it should be specified whether the same prescaler is used for the CAN CC and CAN FD bit rates. This setting is recommended and should only be disabled in exceptional cases. Once everything has been configured, click “Press to calculate bit rates” at “red 14” to calculate the bit-timing register values. The results for the CAN bit-timing register are then shown in the “Nominal bit rate” table (see Figure 4). When you select an entry here, the corresponding results for the CAN FD bit-timing register appear in the second table, “CAN-FD data bit rate”.

Both tables are sorted, with the best results shown first. The entries are color-coded as shown in Table 2.

Table 2: Meaning of colors in the bit-rate tables (Source: MHS-Elektronik)

GREEN	Bit-rate tolerance = 0%; sample-point tolerance = 0%
YELLOW	Bit-rate tolerance = 0%; sample-point tolerance > 0%
ORANGE	Bit-rate tolerance > 0%; sample-point tolerance = 0%
RED	Bit-rate tolerance > 0%; sample-point tolerance > 0%

```
//** Nominal bitrate **
//   500 kBit/s Clock:80MHz  PH1=127  PH2=32   SP=80.0%  SJW=32
#define NBTP_CLK3_500K  0x3E007E1F

//** Data phase bitrate **
//     2 MBit/s Clock:80MHz  PH1=29   PH2=10   SP=75.0%  SJW=10
#define DBTP_CLK3_2M  0x00001C99
```

Figure 5: Result of the bit-rate calculation in C source code (Source: MHS-Elektronik)

Now select the desired CAN FD bit-rate entry. Click “Copy to clipboard” to copy the result (see Figure 5) to the clipboard. Then, you can paste it directly into the C source code.

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