

Microcontrollers ApNote

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C504 Important application hints for dead time generation with the Capture / Compare Unit

Correct dead time generation for low duty cycle PWM COUTx output signals requires proper setting of offset and compare registers.

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Important application hints for dead time generation with the Capture / Compare Unit of the C504

The design of the Capture / Compare Unit (CCU) of the C504 microcontroller allows generation of 7 digital output signals without CPU load. A set of Special Function Registers (SFR, see corresponding tables in C504 User's Manual) offers to the users extreme flexibility to choose of possible waveforms, such as pulse width modulation (PWM). By appropriate setting of SFRs, frequency (period register), duty cycles (compare registers) and active / passive levels (COINI register) of output signals can be easily controlled.

These features should be used with respect to the application, e.g. motor control using three phase transistor inverters with automatic dead time generation by the CCU. The dead time is implemented with a 16-bit offset register. In order to generate correct output pulse patterns for three phase transistor inverters, passive levels for highside switches must be inverted compared to those of lowside switches.

After each zero-crossing of Compare Timer 1 (CT1), all output signals (CCx, COUTx, with x=0..2) are at passive level (defined in register COINI). Outputs CCx are switched to active level when CT1 value is equal to the pre-programmed value in the corresponding compare register. The switching of COUTx occurs when CT1 value plus offset value equals the compare value. A duty cycle of 0% for COUTx outputs is achieved when the programmed compare value is equal to the offset value.

Basically, the CCU design allows the user to write any values to offset and compare registers. However, in motor control applications, **the programmed offset value may not exceed the compare value**. This combination is not allowed.

If this condition is violated, the corresponding COUTx output is constantly kept on active level. This can lead to short-circuit current in the corresponding converter's bridge leg. As far as this case is crucial to the target hardware, it is advised (especially at the beginning of software design) to make an additional software check before every change of offset or compare registers.

Example:

```
if (offset_d > compare )
    then offset_p = compare;
    else offset_p = offset_d;
```

```
with:    offset_d = desired offset
         offset_p = programmed offset
         compare  = compare value
```

Such precautions are very helpful for beneficial usage of flexible CCU features in C504-based designs.