

## The PicoPak DDS Clock Multiplier

W.J. Riley  
Hamilton Technical Services  
Beaufort, SC 29907 USA

The PicoPak Clock Measurement Module uses a DDS synthesizer to generate a phase controllable waveform close to the signal input frequency. The AD9951 DDS chip uses an internal clock multiplier that is applied to the 10 MHz reference input. The clock multiplier factor is normally set to x12, producing a 120 MHz DDS clock frequency which is satisfactory over the specified PicoPak operating frequency range of 5 to 15 MHz. The main considerations are that the DDS generate a sufficient number of samples at the signal frequency to provide adequate spectral purity, and that it have adequate resolution for setting the DDS closely to that of the signal. The Configure screen of the PicoPak Windows user interface application displays this clock multiplier factor, but does not allow it to be changed.

The DDS clock multiplier factor can, however, be temporarily changed with the “M=XX” command (where XX is the multiplier factor in hex) if the PicoPak is operated using an ASCII terminal program. Issuing the “M↵” or “M?” command shows the multiplier factor, the former with text labels and prompts. It will be restored to the default value of x12 when the module is reset or repowered.

The PicoPak can accept multiplier factors between x4 to x20 (04 to 0C hex), the allowable range for the AD9951 DDS chip, but only values between x10 to x14 should be used, and the default value of x12 is recommended. The DDS output frequency,  $f_{\text{DDS}}$ , is equal to

$$f_{\text{DDS}} = f_{\text{Ref}} \cdot M \cdot W / 2^{32}$$

where:  $f_{\text{Ref}}$  = Reference input frequency (normally 10 MHz)  
M = DDS clock multiplier factor (normally 12)  
W = DDS tuning word (15555555 hex for  $\approx$  10 MHz)

The relevant parameters for multiplier factors between x10 and x14 at 10 MHz are shown in the following table:

PicoPak DDS Clock Multiplier Factors and Parameters			
DDS Clock Multiplier Factor	Closest 10 MHz DDS Word (hex)	Frequency Error, mHz (pp10 <sup>10</sup> )	Frequency Resolution, mHz (pp10 <sup>10</sup> )
x14	12492492	-9.31	32.60
x13	13B13B14	+9.31	30.27
x12 (Nominal)	15555555	-9.31	27.94
x11	1745D174	-9.31	25.61
x10	1999999A	+9.32	23.28

For example, with a 10 MHz reference input and the default DDS tuning word equal to 15555555 hex , if the multiplier factor is changed from x12 (0C hex) to x10 (0A hex), the nominal DDS output frequency will change from 10 MHz to 8.333 MHz. The frequency can be restored to 10 MHz with W=1999999A hex.

The multiplier factor can also be changed in the PicoPak Windows® graphical user interface program by manually setting the Mult= value in the [Preferences] section of the PicoPak.ini configuration file. That value is a read-only parameter.

There is no particular reason to change the clock multiplier factor for normal PicoPak operation. It has no effect on the phase resolution. A lower multiplier factor does improve the DDS frequency resolution, but that is no particular advantage since the PicoPak module works fine with the x12 setting, and a lower value causes degraded spectral purity of the DDS output.

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W.J. Riley  
Hamilton Technical Services  
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