

A modification of Terry Feagin's order 10 Runge-Kutta scheme with an order 8 embedded scheme

The 17 stage, order 10 Runge-Kutta scheme considered here may be regarded as a modification of a scheme of Terry Feagin, University of Houston – Clear Lake, Houston, Texas, USA.

Note: The embedded order 8 scheme requires 3 stages to be added to the 17 stage, order 10 scheme.

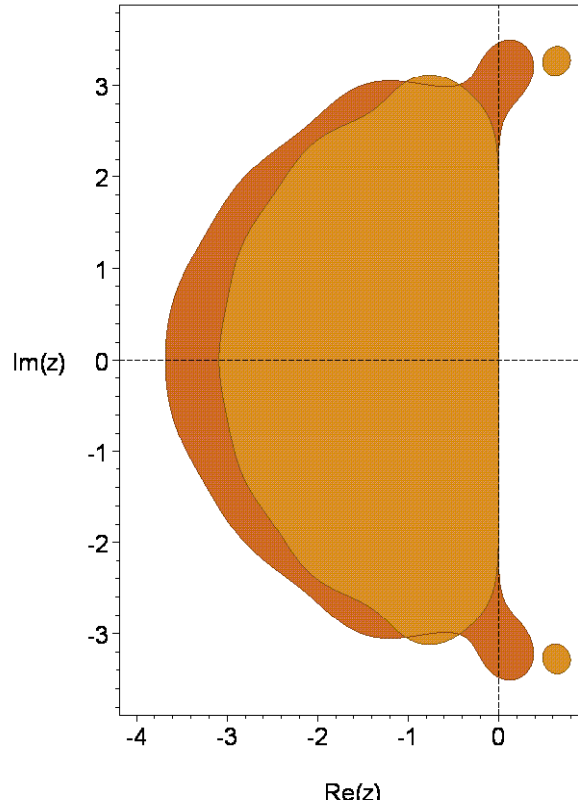
The principal error norm of the order 10 scheme, that is, the 2-norm of the principal error terms is: $0.2587312600 \times 10^{(-5)}$.

The principal error norm of the embedded order 8 scheme is: $0.6106846252 \times 10^{(-5)}$.

The maximum magnitude of the linking coefficients is 10.92934022.

The 2-norm of the linking coefficients is 16.14237345.

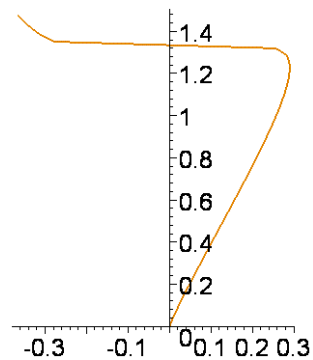
The stability regions for the two schemes are shown in the following picture.



The stability region of the order 8 scheme appears in the darker shade.

The real stability intervals of the order 10 and 8 schemes are respectively $[-3.0888, 0]$ and $[-3.6821, 0]$.

The following picture shows the result of distorting the boundary curve of the stability region of the order 10 scheme horizontally by taking the 11th root of the real part of points along the curve.



The stability region intersects the nonnegative imaginary axis in the interval $[0, 1.3303]$.

The coefficients correct to 85 digits are as follows.

c[2]=.4505949812938948765926891820735865028371954312934488380821704046826717694986932558145,
c[3]=.5277788391960049917980396735815307121456391761690273312621304572846140724562422311857,
c[4]=.7916682587940074876970595103722960682184587642535409968931956859269211086843633467786,
c[5]=.2916682587940074876970595103722960682184587642535409968931956859269211086843633467786,
c[6]=.4776860056810430751727862757186121373012818244923024511303040779439408318219133838868,
c[7]=.7722894855630386025741773548792366374533673421384009264872124854273494266074079325221,
c[8]=.2277871266979577279997863152015551524776388332100645228438421756303747587235197109544,
c[9]=.8825276619647323464255014869796690751828678442680521196637911779185276585194132570617,
c[10]=.6426157582403225481570754970204395359595017363632126959098752082638489654570997990908,
c[11]=.3573842417596774518429245029795604640404982636367873040901247917361510345429002009092,
c[12]=.1174723380352676535744985130203309248171321557319478803362088220814723414805867429383,
c[13]=.7722894855630386025741773548792366374533673421384009264872124854273494266074079325221,
c[14]=.2916682587940074876970595103722960682184587642535409968931956859269211086843633467786,
c[15]=.5277788391960049917980396735815307121456391761690273312621304572846140724562422311857,
c[16]=.4505949812938948765926891820735865028371954312934488380821704046826717694986932558145,
c[17]=1.,
c[18]=.2813815050326419941197517628218510898115738239664117959552576960655524985916053899920,
c[19]=.6424631086179823326591362345404877543111115299483691458821949532989912959073448217775,
c[20]=1.,

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a[3,1]=.2186869555012313775435445688931855975417879178694749147796177692803053557706140050218,
a[3,2]=.3090918836947736142544951046883451146038512582995524164825126880043087166856282261639,
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a[7,1]=.1155460856229761787726155429364810397036132039246857359317119636913029366157118709907,
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a[20,13]=0.,
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a[20,15]=0.,
a[20,16]=0.,
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a[20,18]=-.6488657734690548522336565636304079560554701030174071203398633583371828873282950046332,
a[20,19]=-.10.92934022066749816923967392987453328861387344682969540273529968680236063111363270910,

b[1]=.333e-1,
b[2]=.3478260869565217391304347826086956521739130434782608695652173913043478260869565217391e-1,
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b[4]=0.,
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b[6]=0.,
b[7]=.1775456919060052219321148825065274151436031331592689295039164490861618798955613577023,
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b*[1]=.3749758279969435765154931305540998743370058990687527735611147922076222373360417822956e-1,
b*[2]=0.,
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b*[13]=0.,
b*[14]=0.,
b*[15]=0.,
b*[16]=0.,
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b*[19]=-1.123249875643322250792667060065128039127510419437824385006085350743665599582439088468,
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