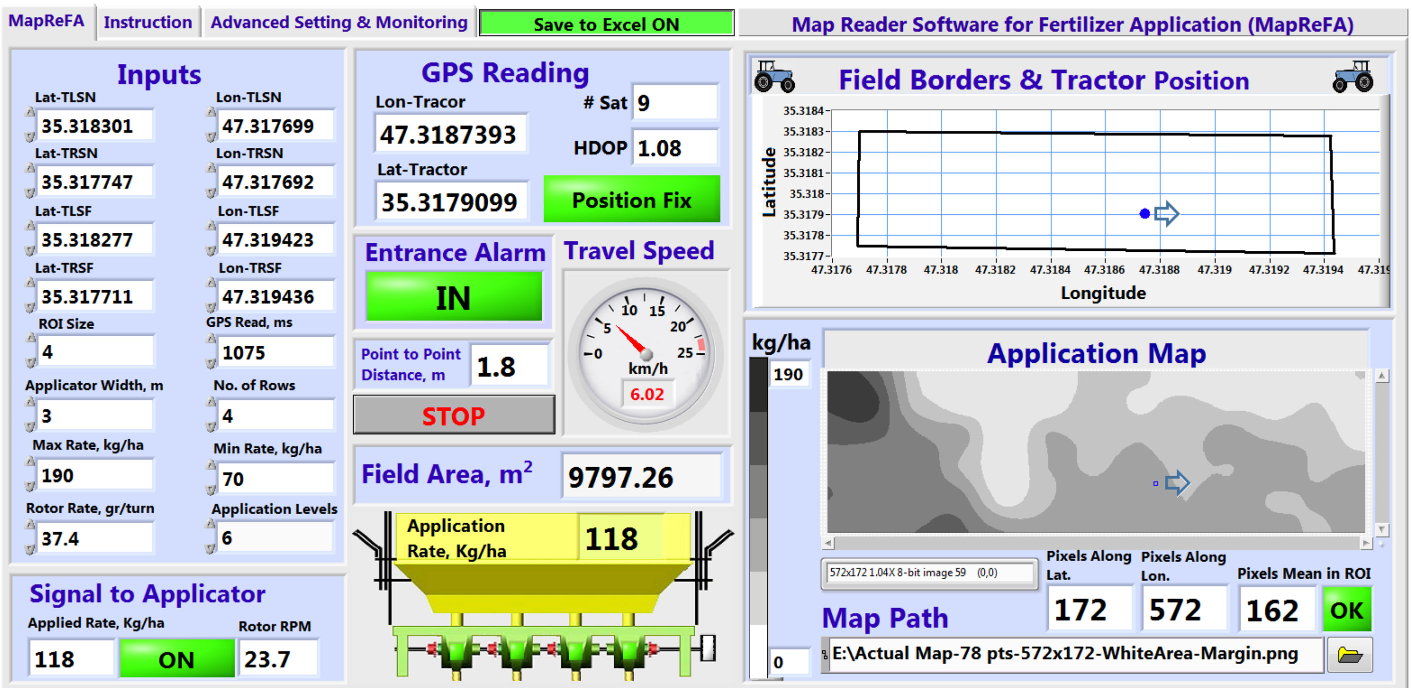
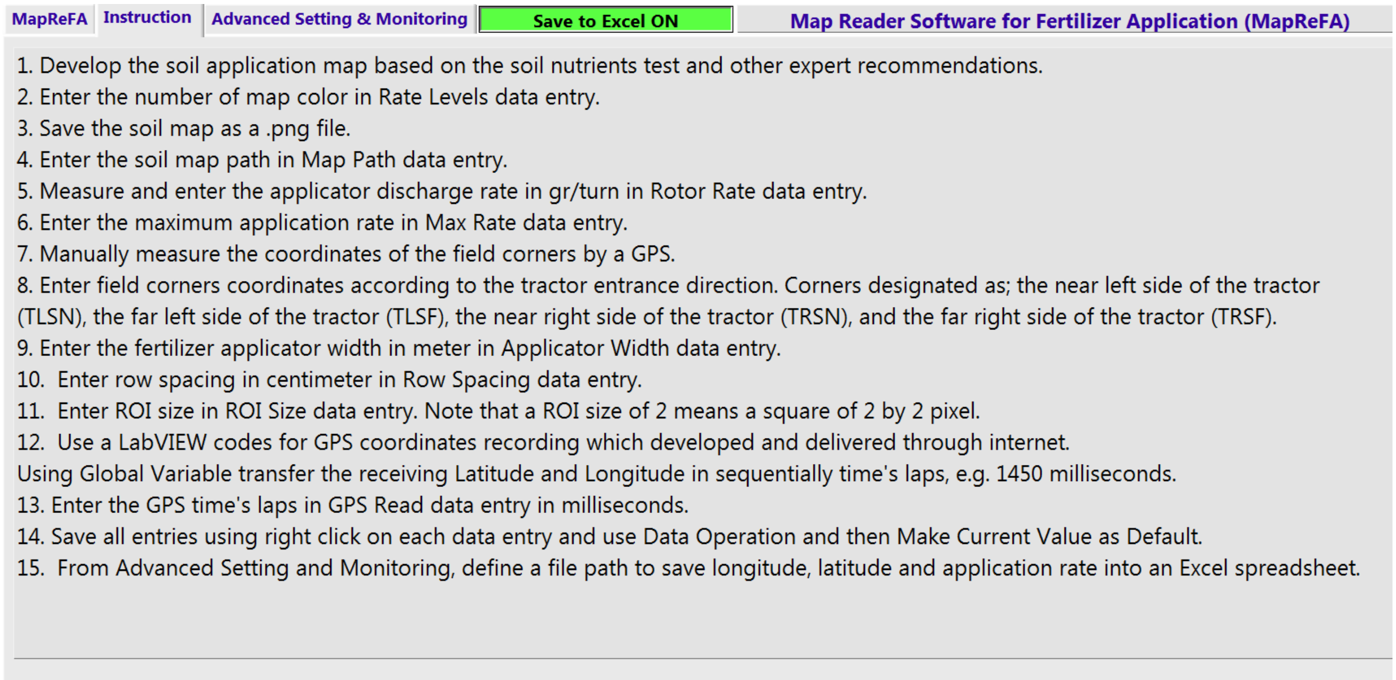
Annex. MapReFA (Map Reader Software for Fertilizer Application) developed entirely in LabVIEW programming environment to directly read a soil map image pixel-by-pixel for providing the required information to tailor the fertilizer rate, regardless of which software (*e.g.* Surfer or ArcGIS) has been used for map generation. The program was developed using the sequence structure which is available in all LabVIEW versions.

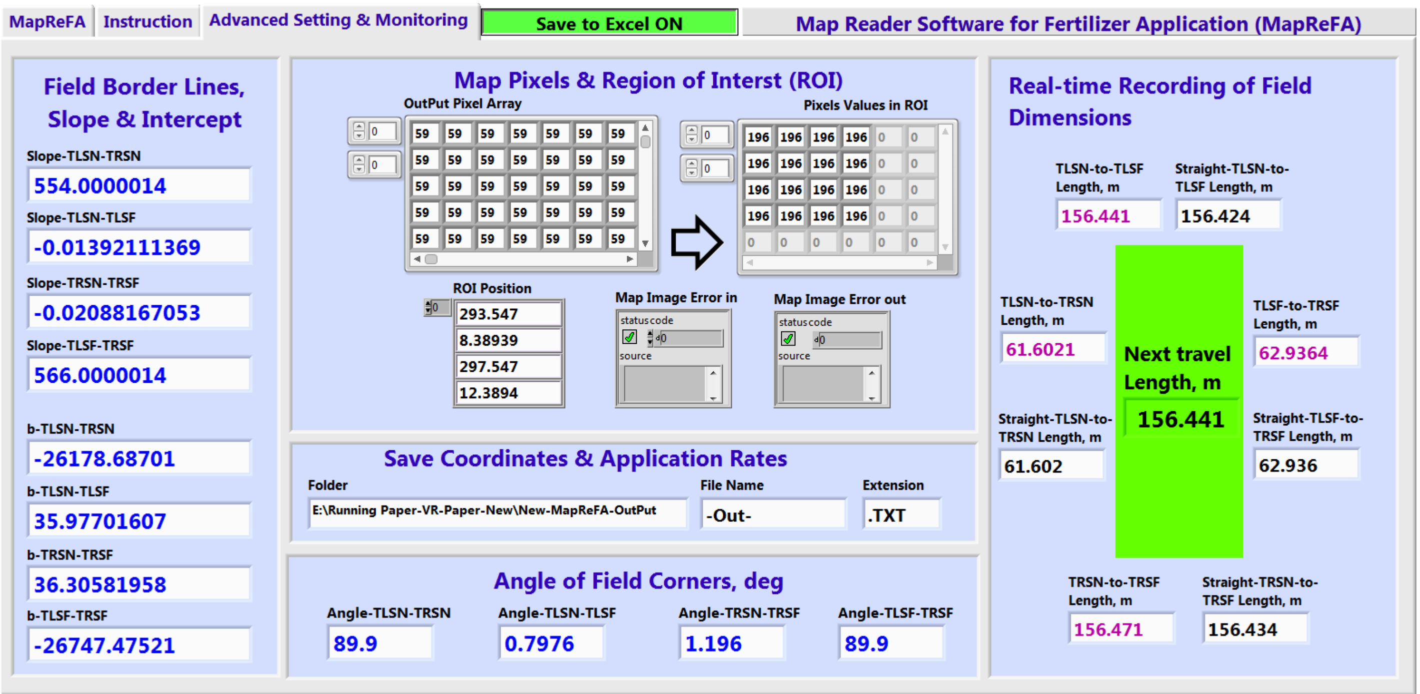


A1. Screenshot of the MapReFA main panel. Lon-TLSN, longitude of tractor left side near. Lat-TLSN, latitude of tractor left side near. Lon-TLS, longitude of tractor left side far. Lat-TLSF, latitude of tractor left side far. Lon-TR, longitude of tractor right side near. Lat-TRSN, latitude of tractor right side near. Lon-TRSF, longitude of tractor right side far. Lat-TRSF, latitude of tractor right side far. ROI, region of intrest. HDOP, horizontal dilution of precision.

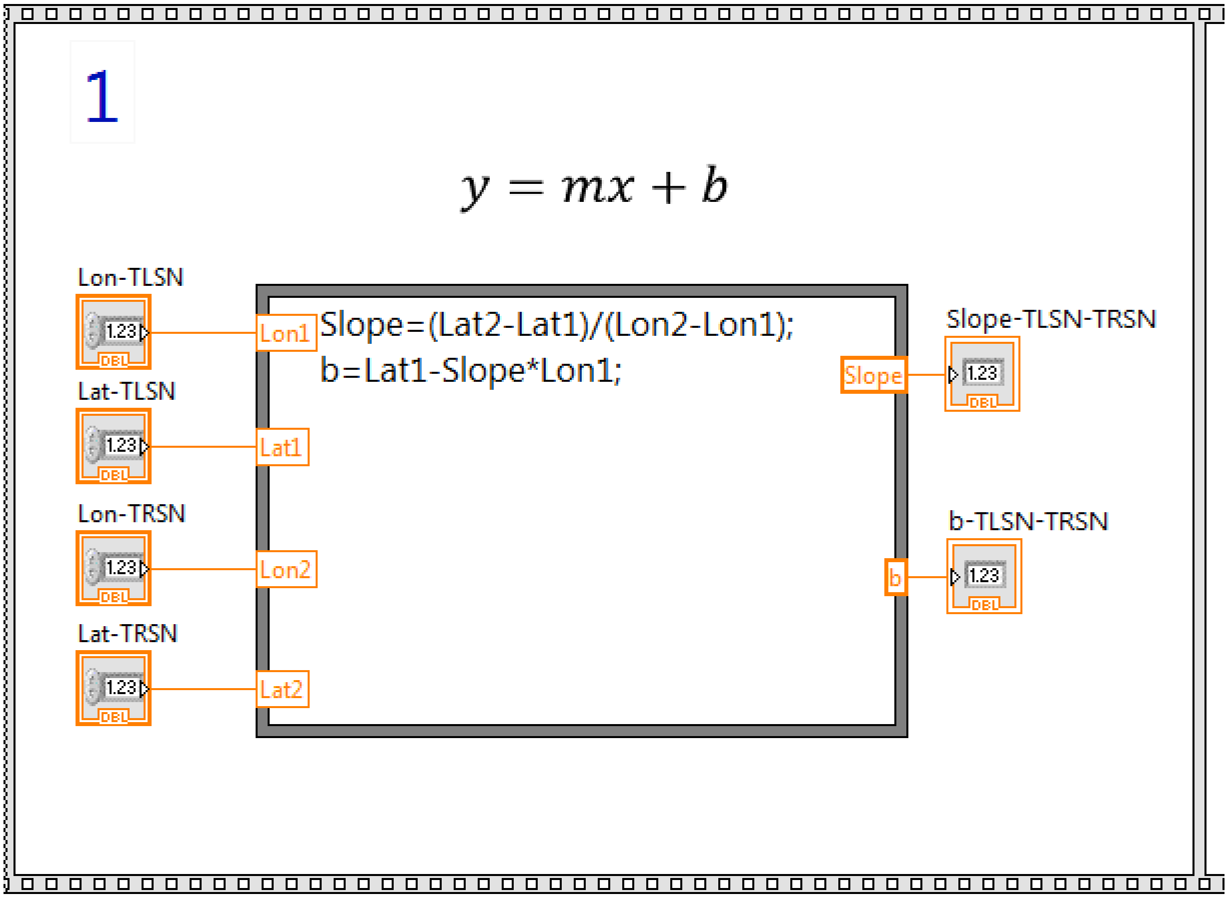


1. Develop the soil application map based on the soil nutrients test and other expert recommendations.
2. Enter the number of map color in Rate Levels data entry.
3. Save the soil map as a .png file.
4. Enter the soil map path in Map Path data entry.
5. Measure and enter the applicator discharge rate in gr/turn in Rotor Rate data entry.
6. Enter the maximum application rate in Max Rate data entry.
7. Manually measure the coordinates of the field corners by a GPS.
8. Enter field corners coordinates according to the tractor entrance direction. Corners designated as; the near left side of the tractor (TLSN), the far left side of the tractor (TLSF), the near right side of the tractor (TRSN), and the far right side of the tractor (TRSF).
9. Enter the fertilizer applicator width in meter in Applicator Width data entry.
10. Enter row spacing in centimeter in Row Spacing data entry.
11. Enter ROI size in ROI Size data entry. Note that a ROI size of 2 means a square of 2 by 2 pixel.
12. Use a LabVIEW codes for GPS coordinates recording which developed and delivered through internet.
Using Global Variable transfer the receiving Latitude and Longitude in sequentially time's laps, e.g. 1450 milliseconds.
13. Enter the GPS time's laps in GPS Read data entry in milliseconds.
14. Save all entries using right click on each data entry and use Data Operation and then Make Current Value as Default.
15. From Advanced Setting and Monitoring, define a file path to save longitude, latitude and application rate into an Excel spreadsheet.

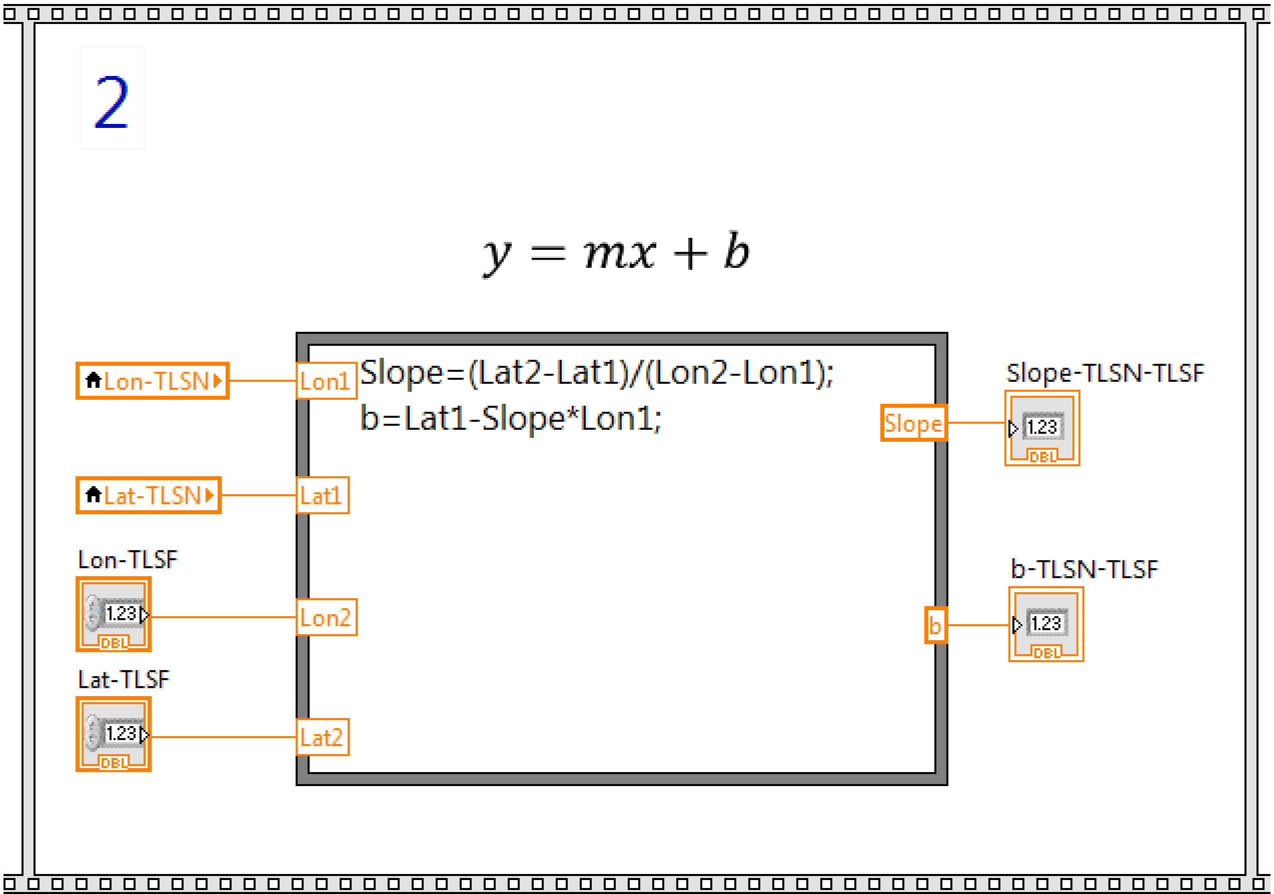
A2. The instruction the MapReFA users



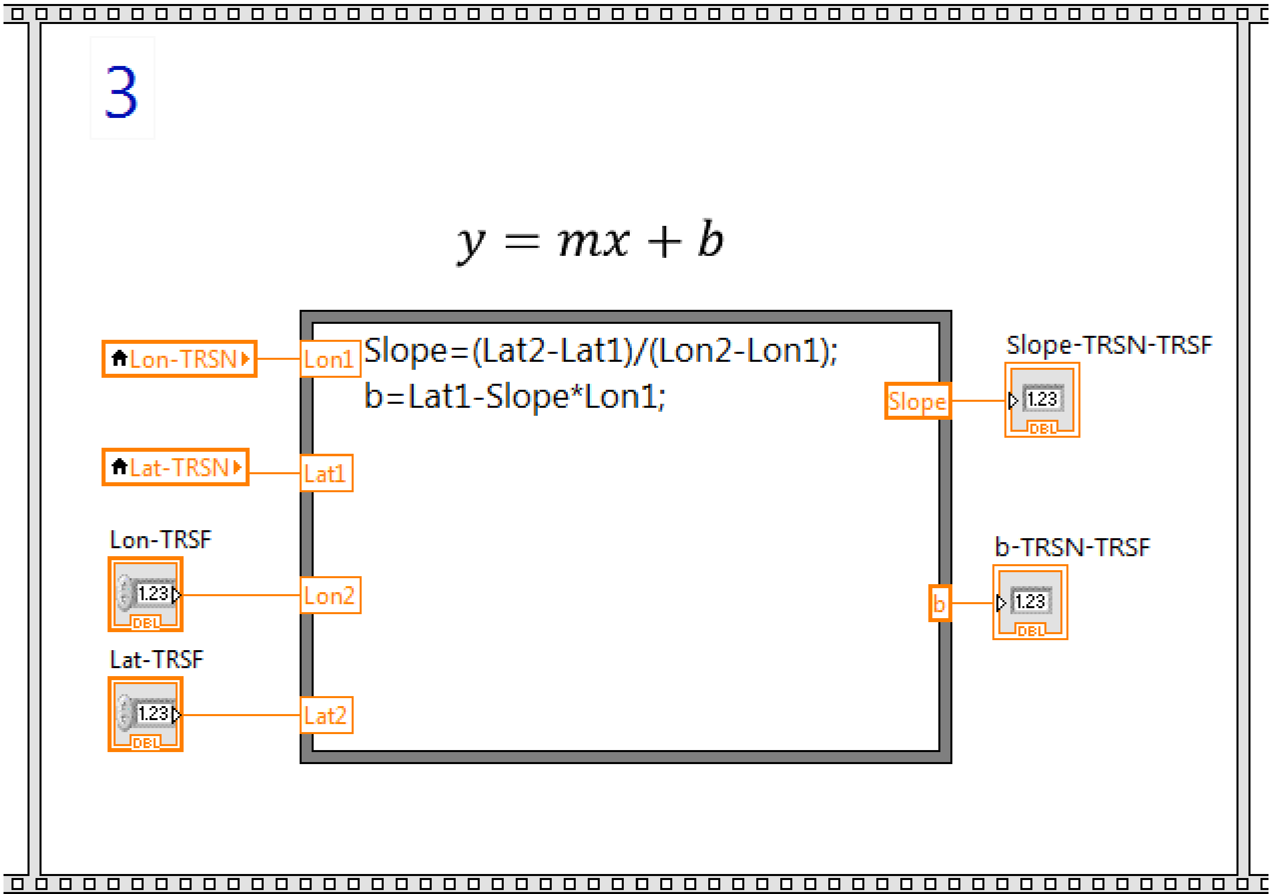
A3. Advanced setting and monitoring



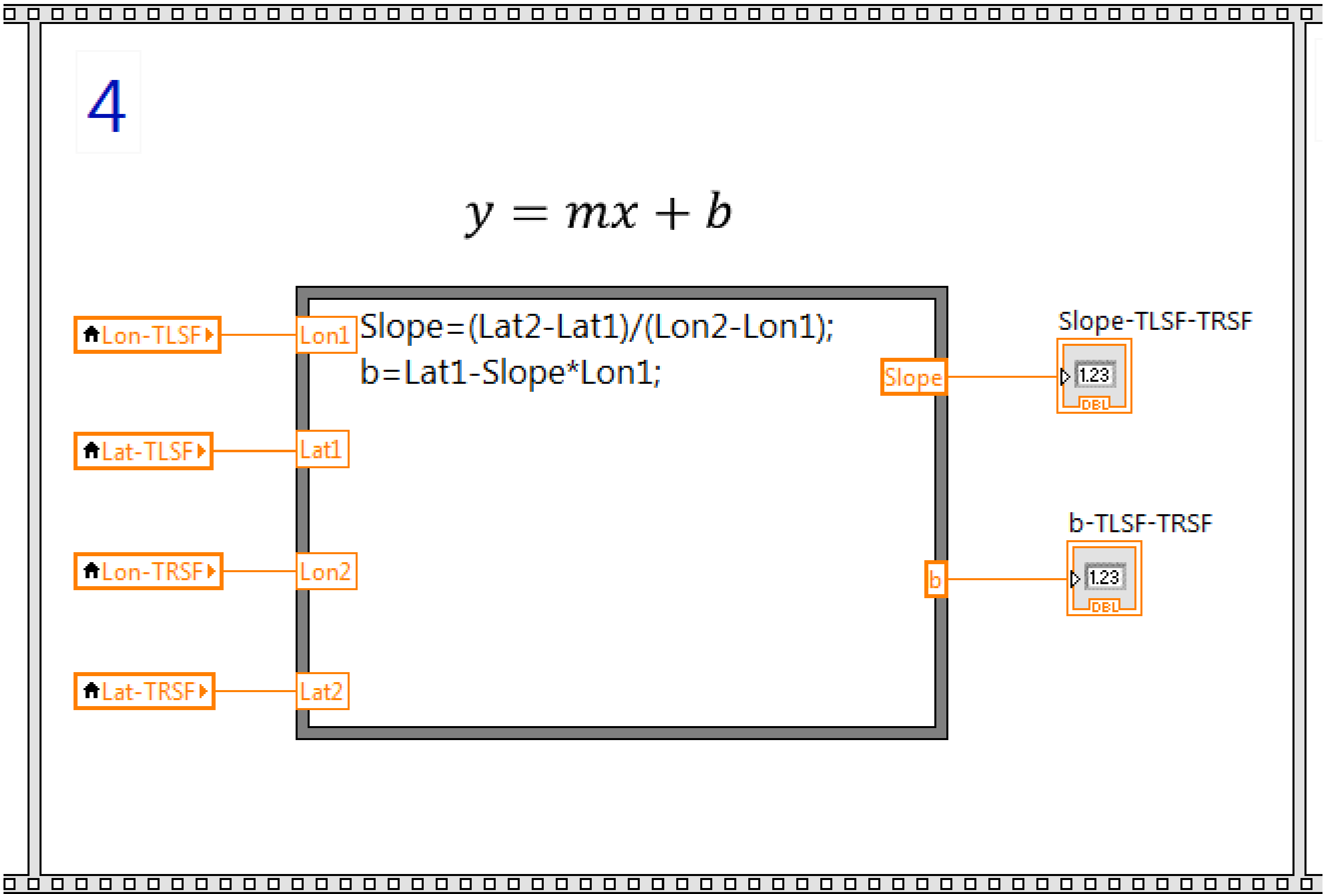
A4. Drawing the line of tractor left side near to tractor right side near



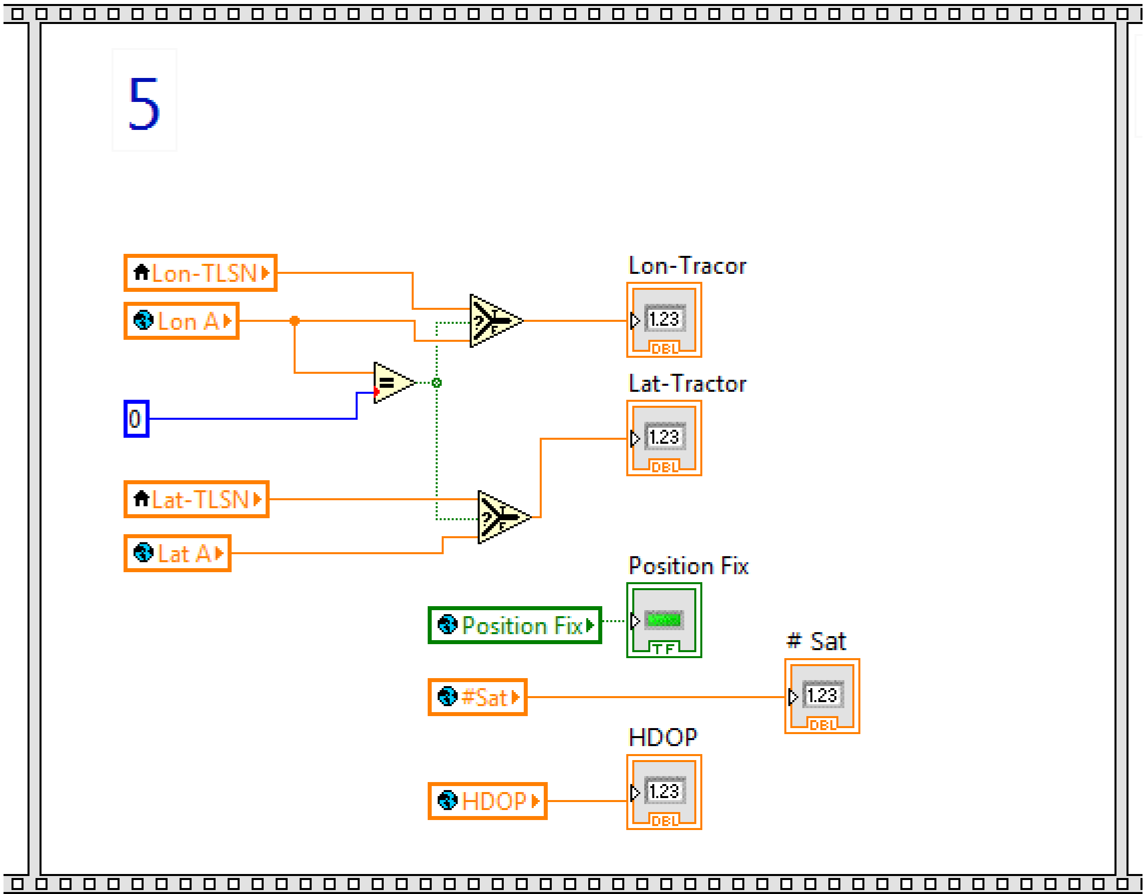
A5. Drawing drawing the line of tractor left side near to tractor left side far



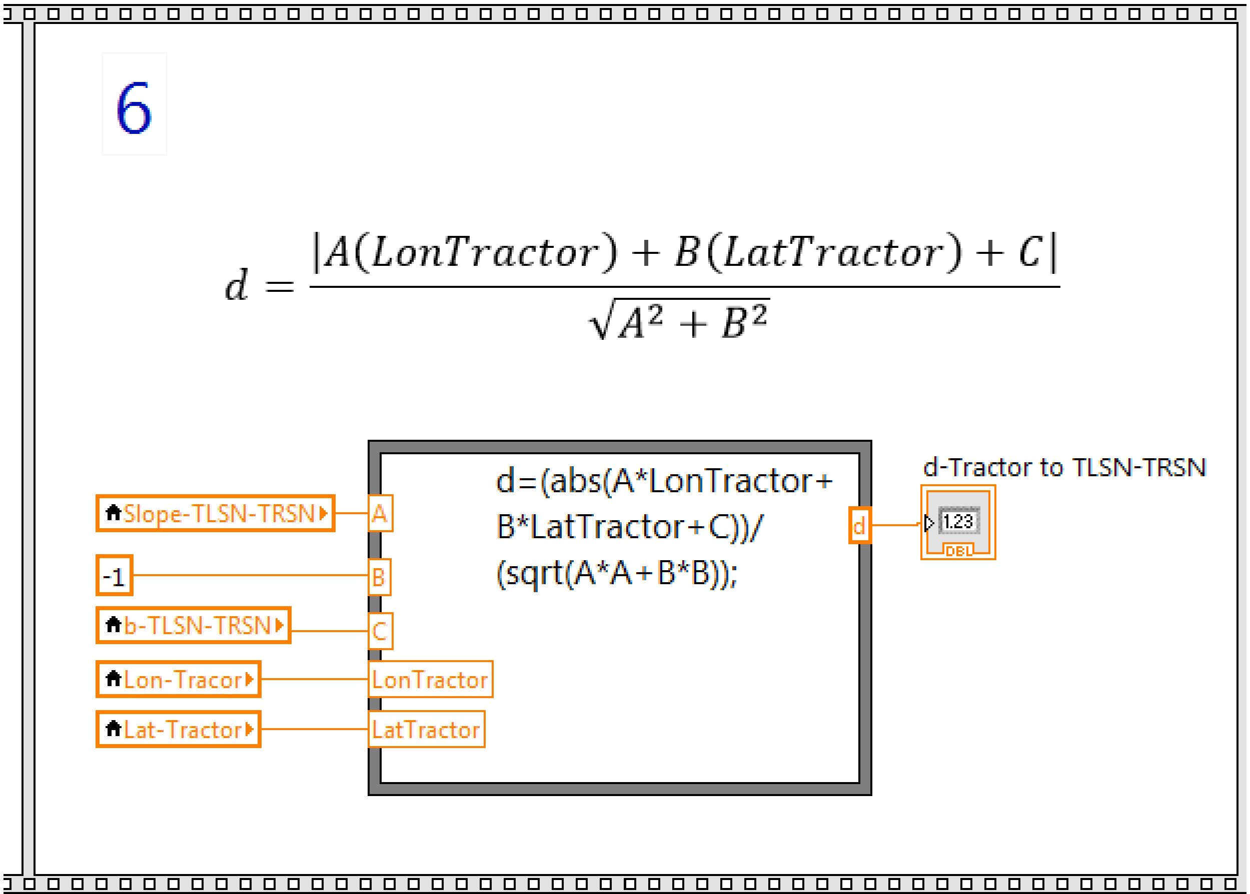
A6. Drawing the line of tractor right side near to tractor right side far



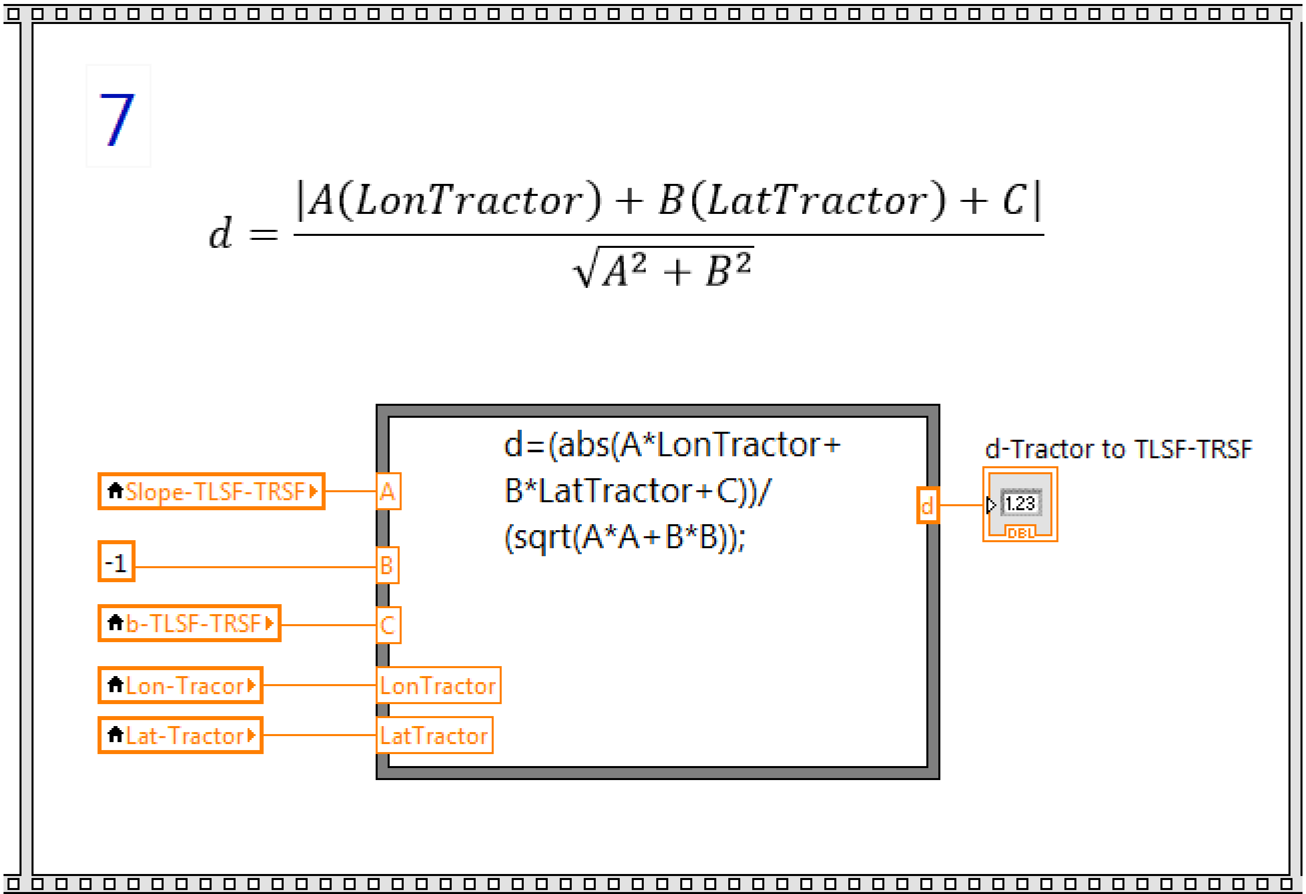
A7. Drawing and drawing the line of tractor left side far to tractor right side far



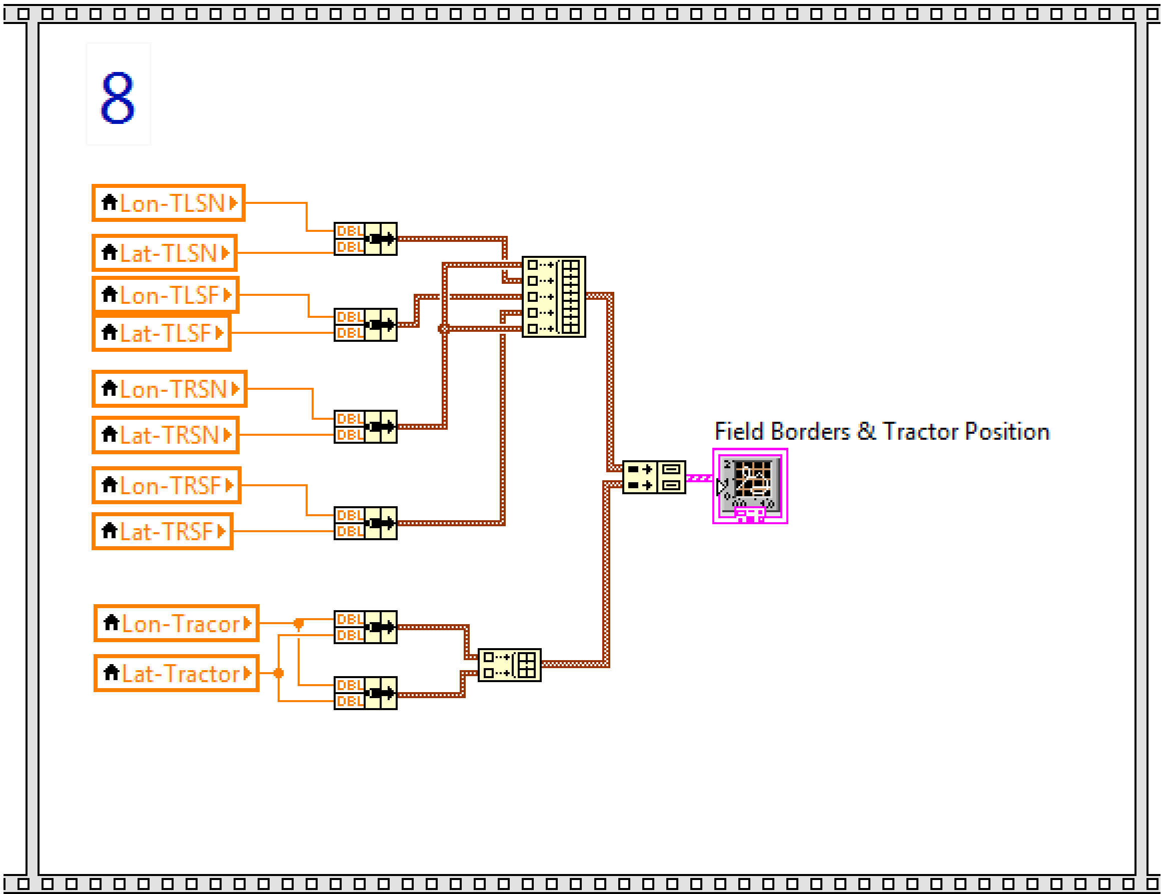
A8. Receiving the tractor coordinates from the GPSCR (GPS Coordinate Recorder) interface



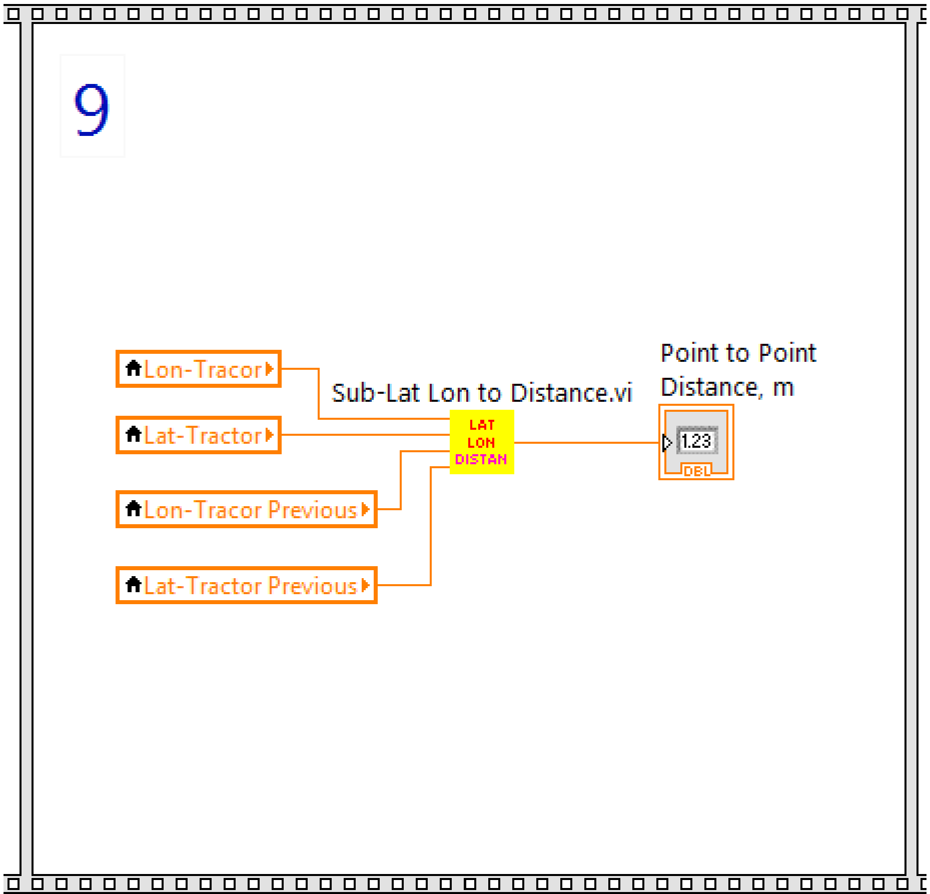
A9. Calculating the perpendicular distance of the tractor to TLSN-TRSN border-line



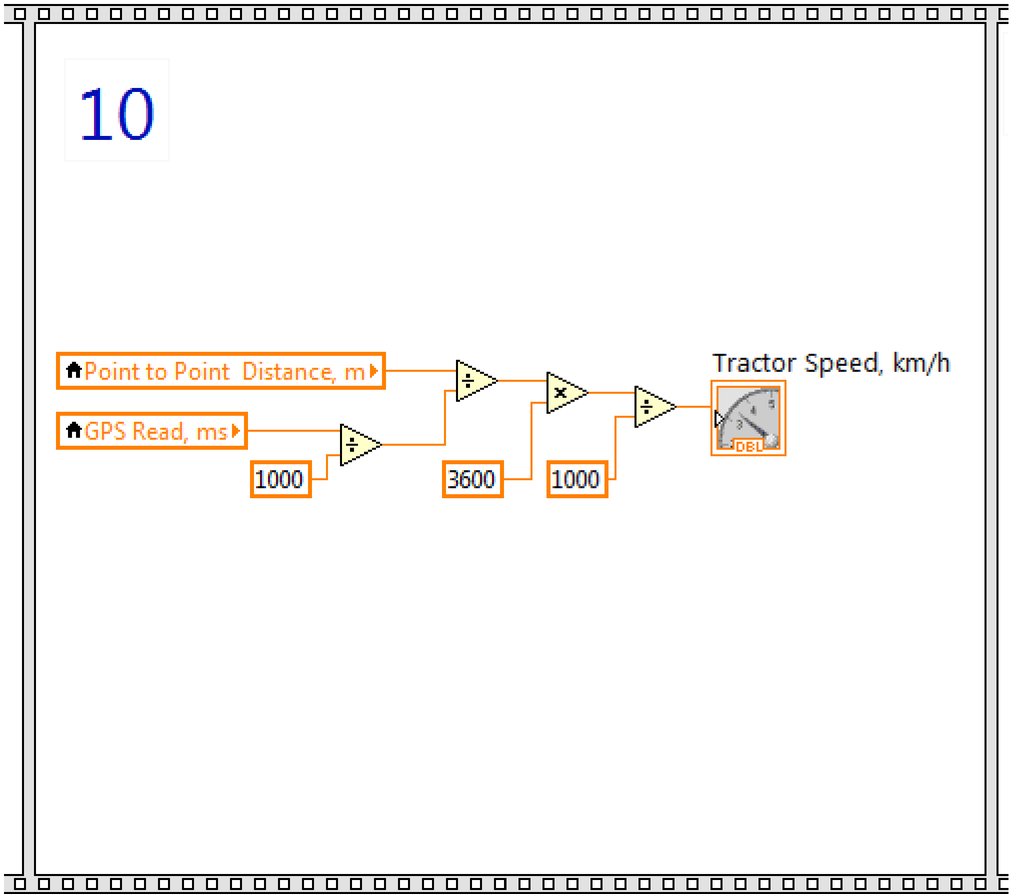
A10. Calculating the perpendicular distance of the tractor to TLSF-TRSF border-line



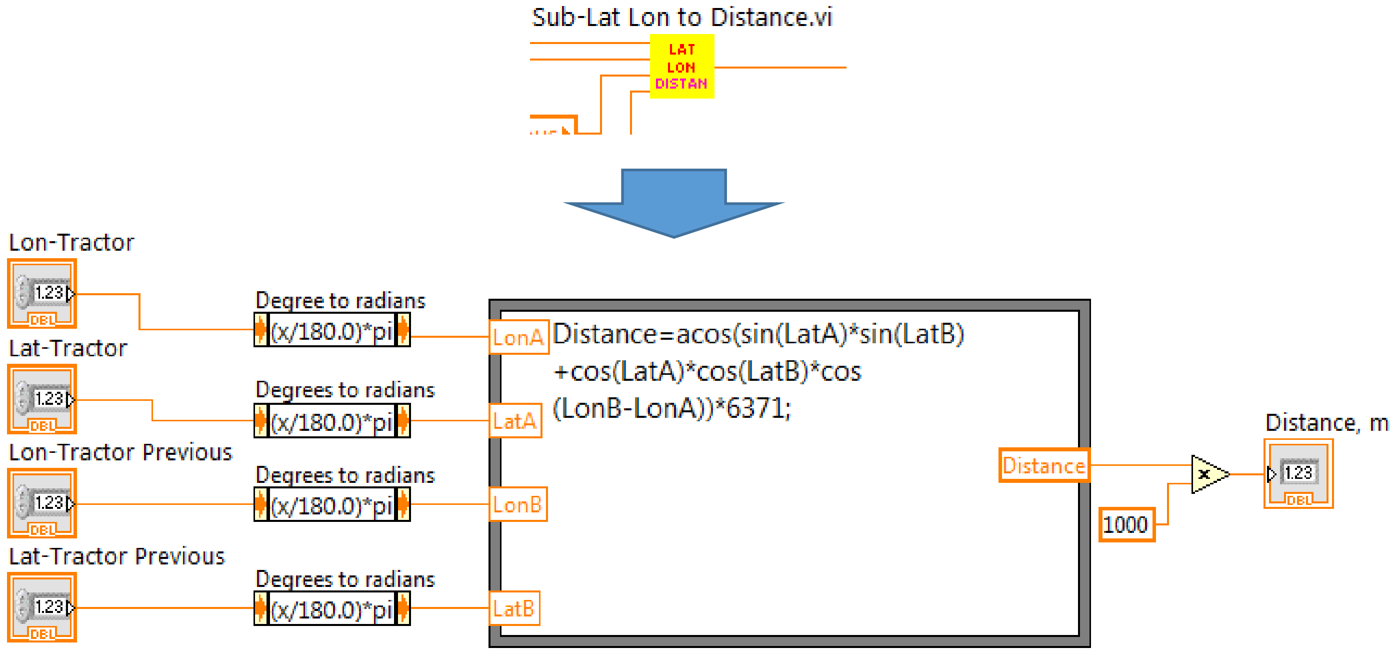
A11. Drawing the farm border graph and locating the tractor position (right)



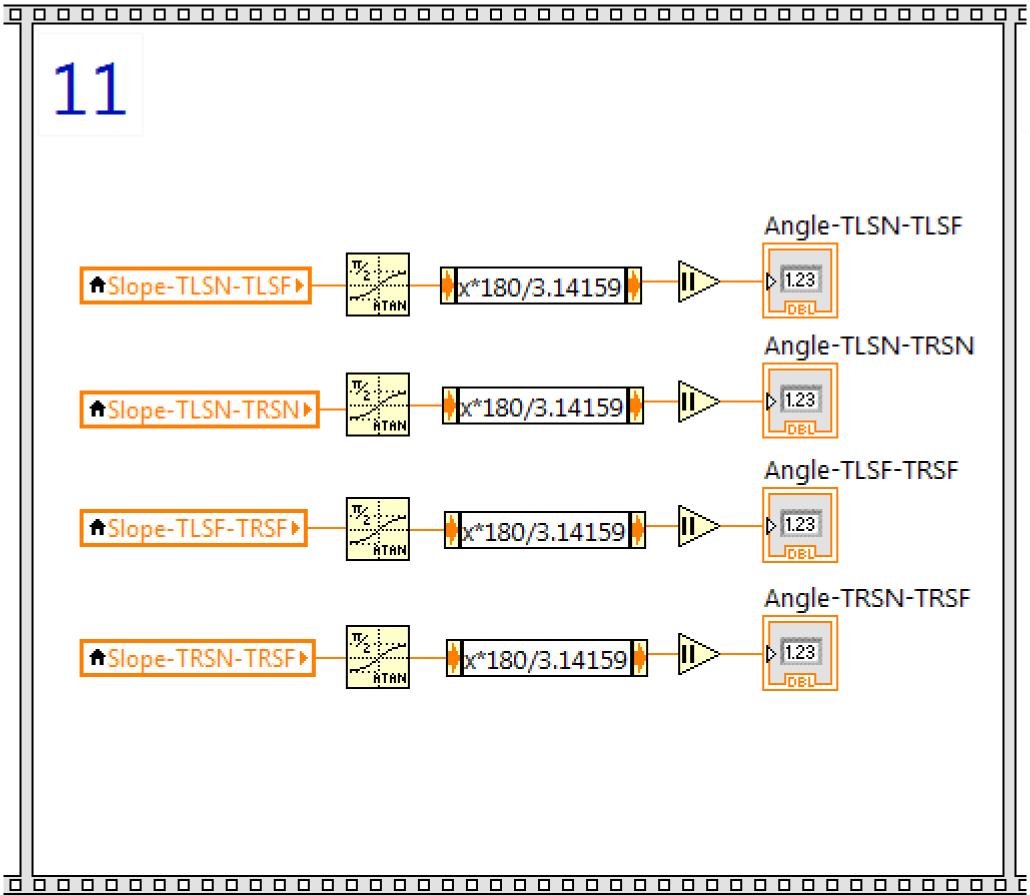
A12. Calculating the distance of two successive GPS reads



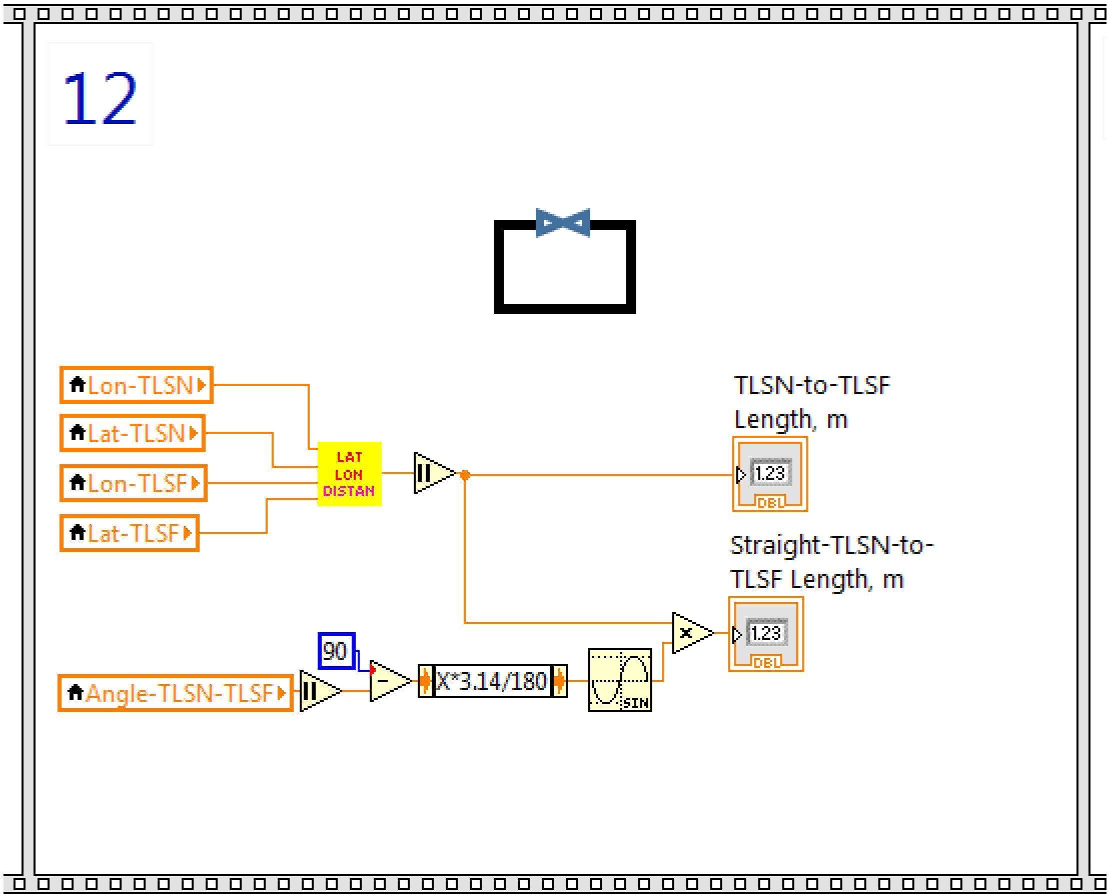
A13. Calculating and monitoring the tractor speed (right)



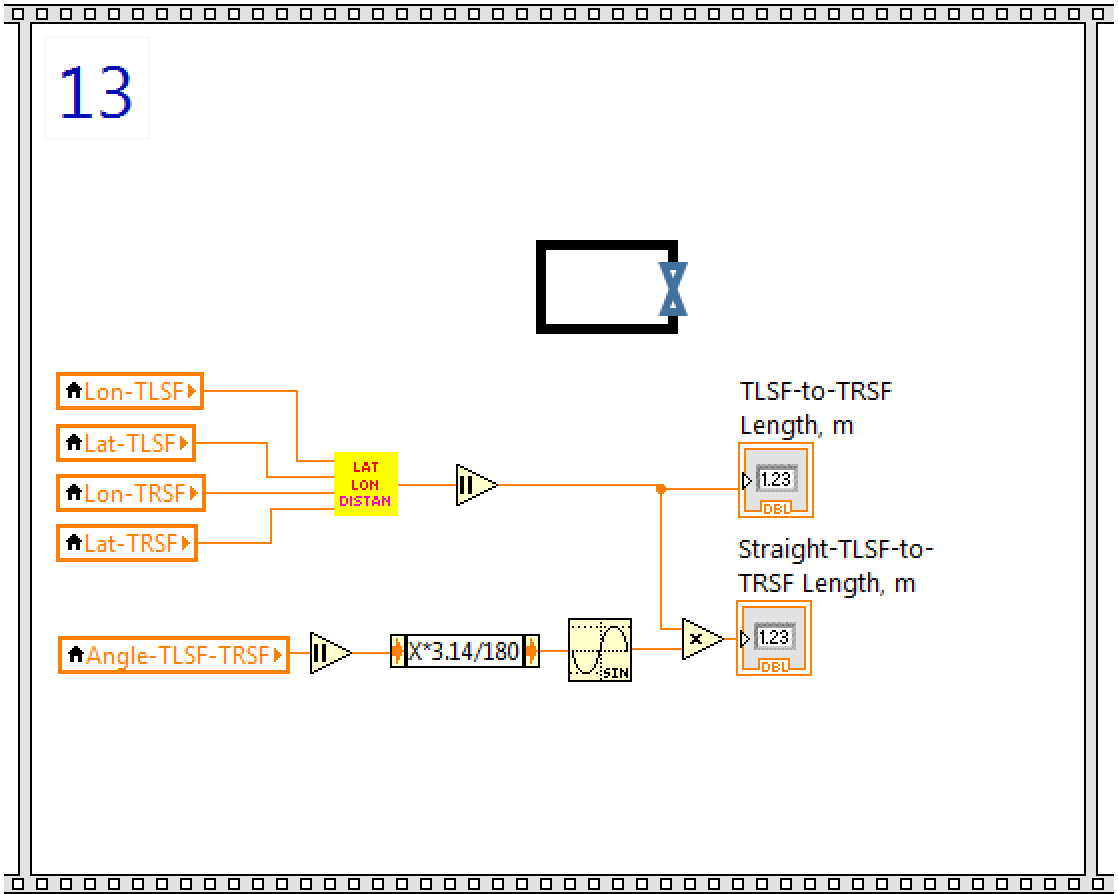
A14. A subprogram to convert longitude and latitude to distance in meter



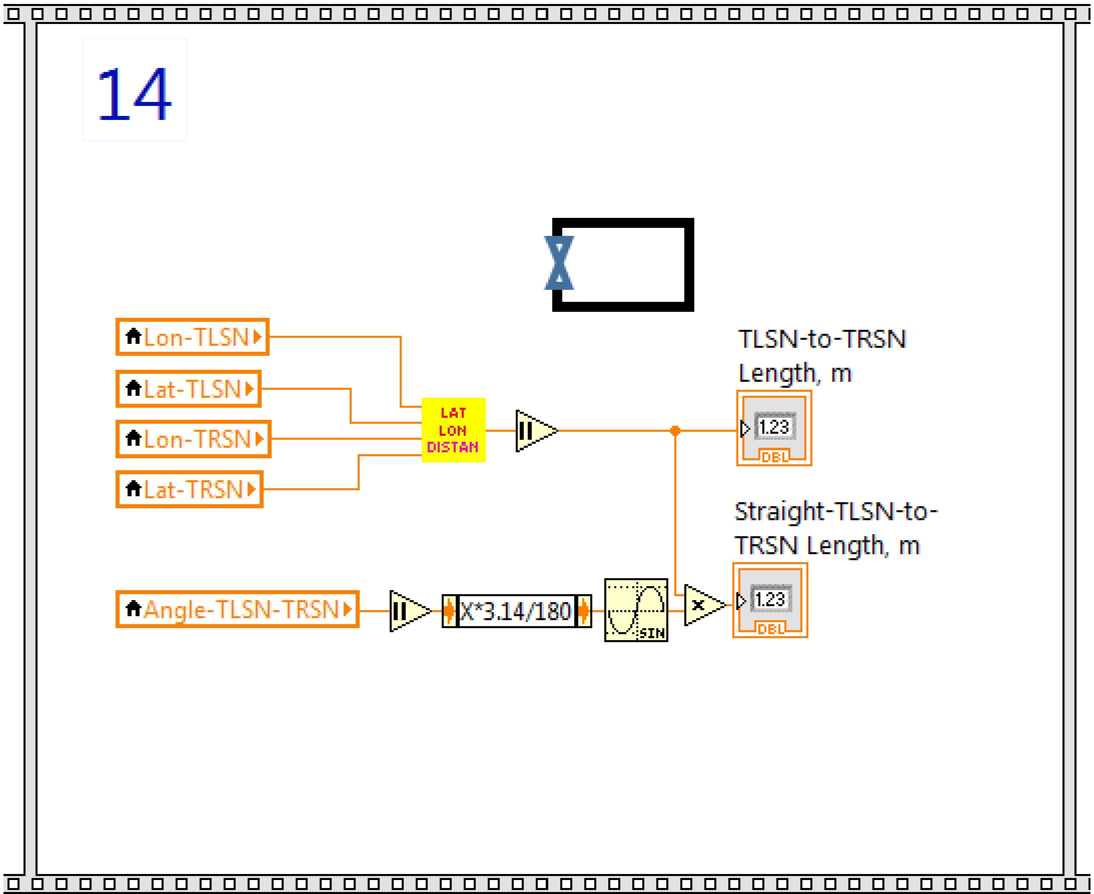
A15. Calculating the farm corner's angles



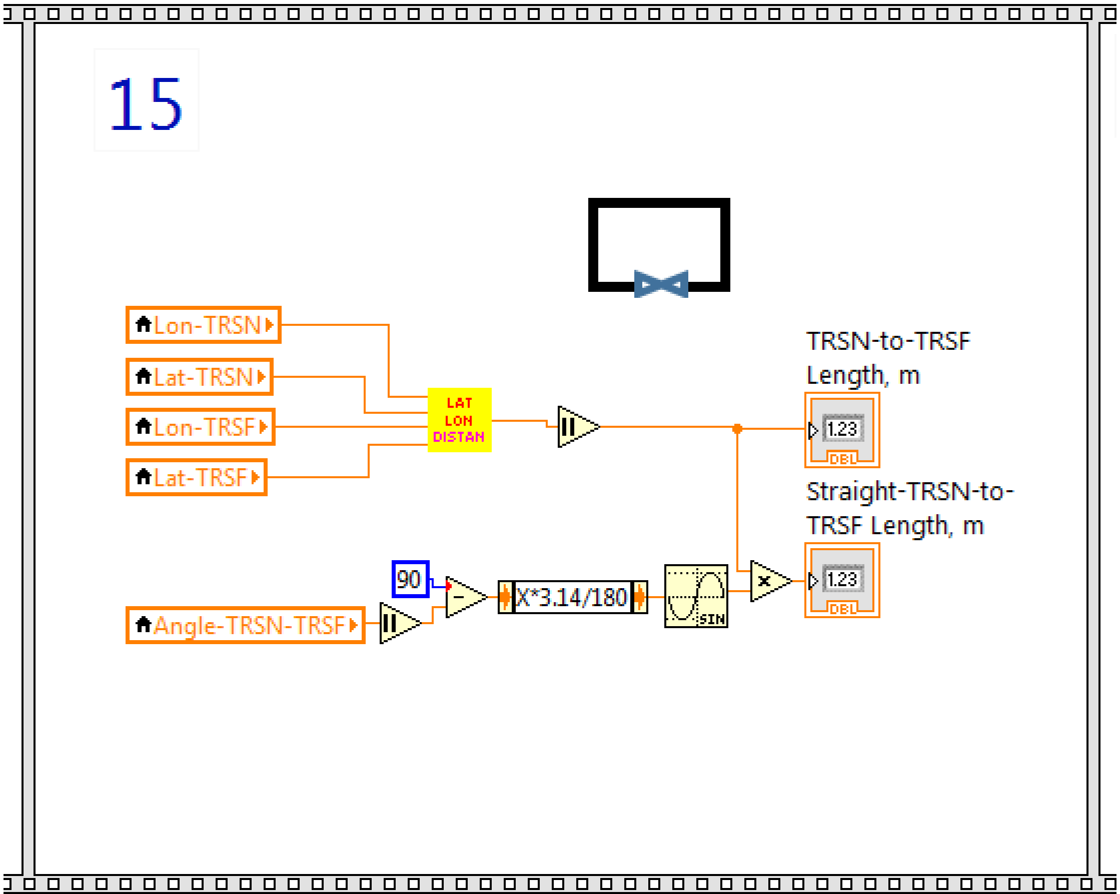
A16. Calculating the border length of TLSN-TLSF



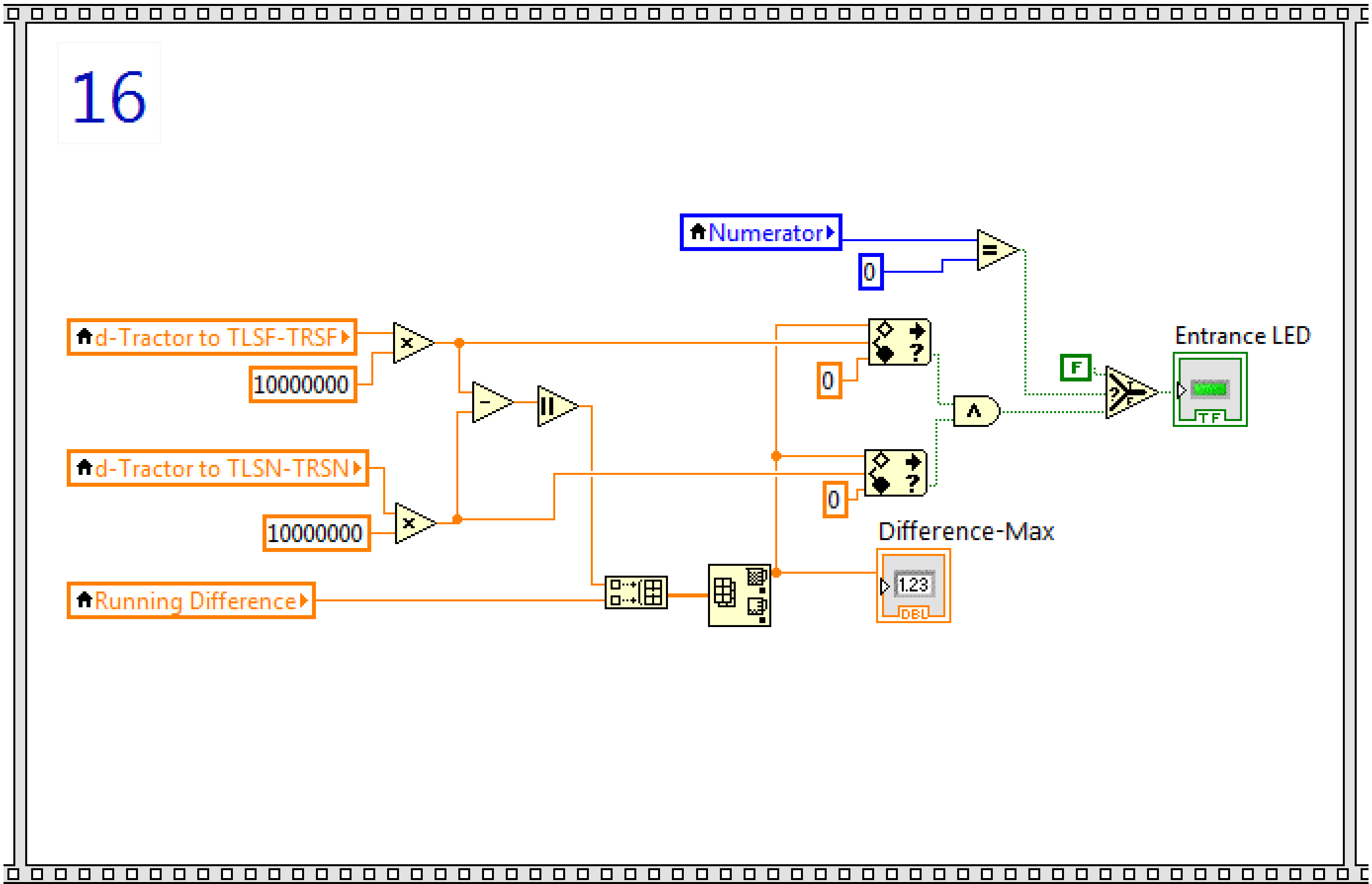
A17. Calculating the border length of TLSF-TRSF



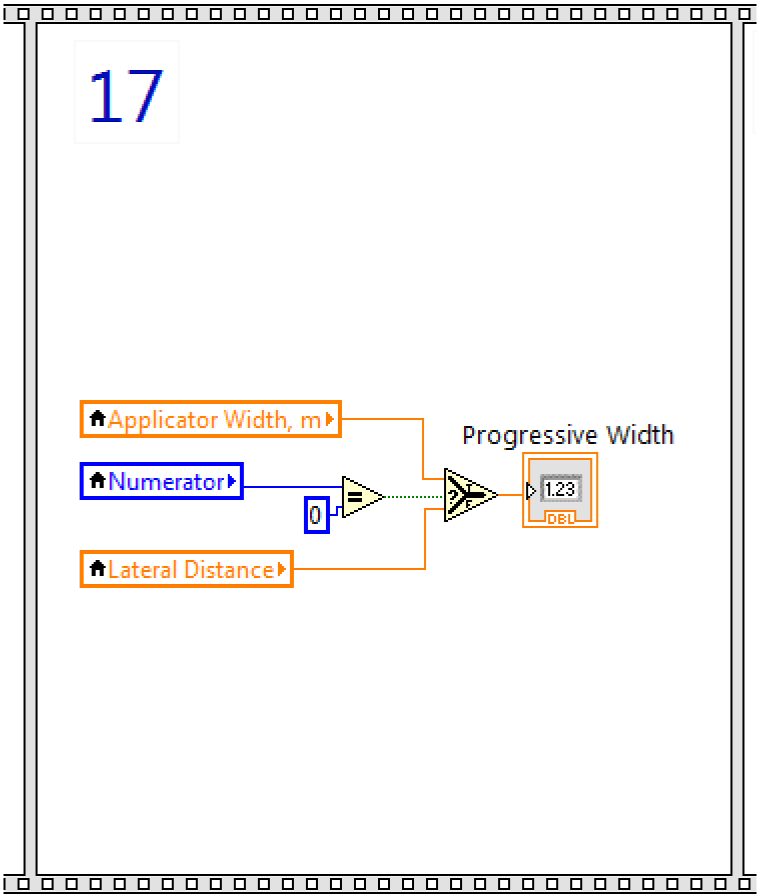
A18. Calculating the border length of TLSN-TRSN



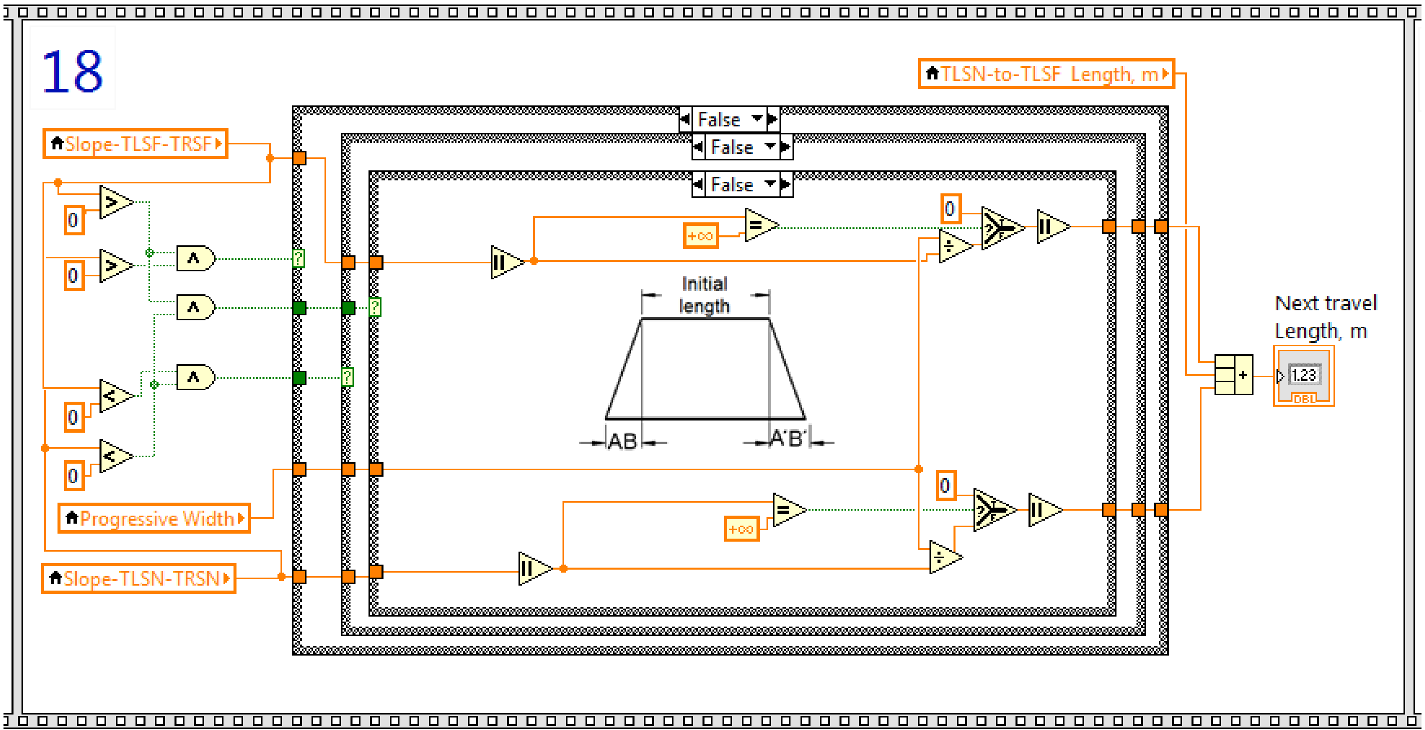
A19. Calculating the border length of TRSF-TRSF



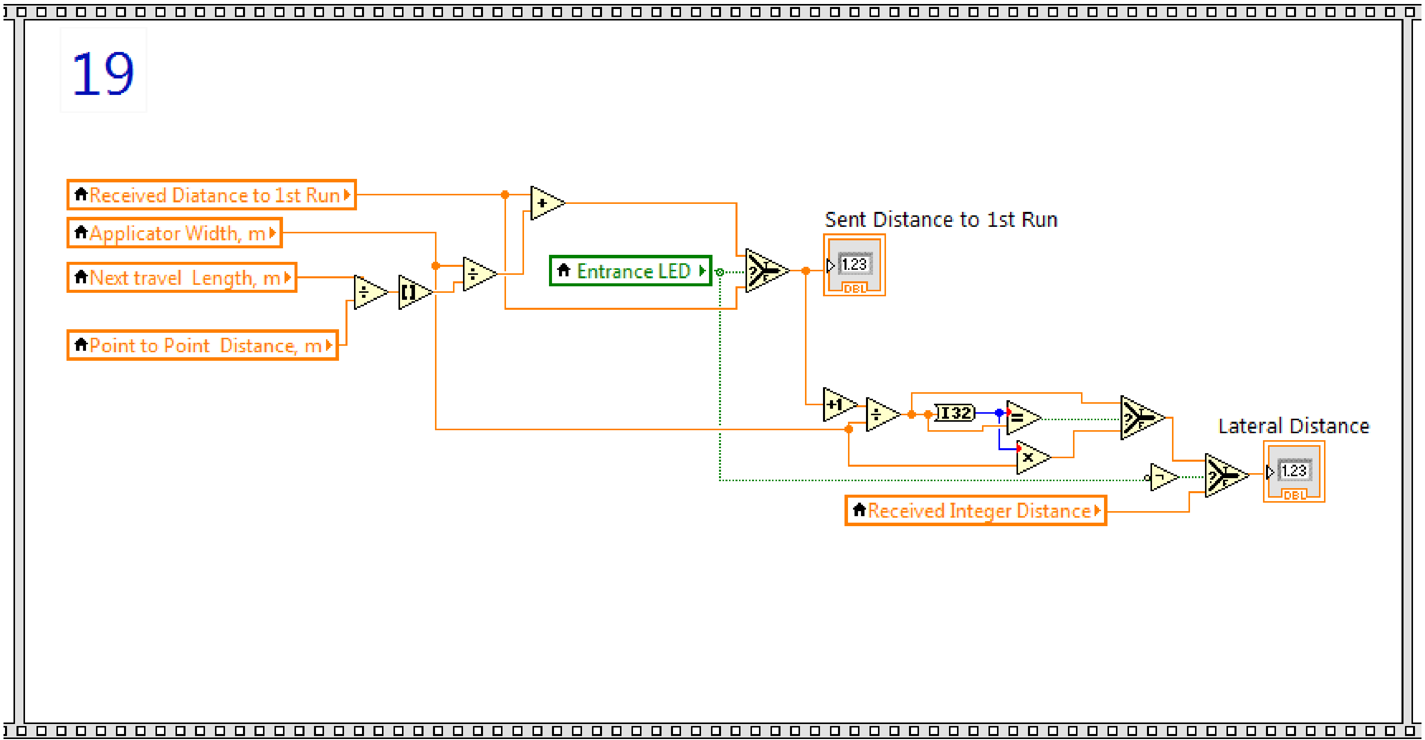
A20. Creating a border crossing alarm



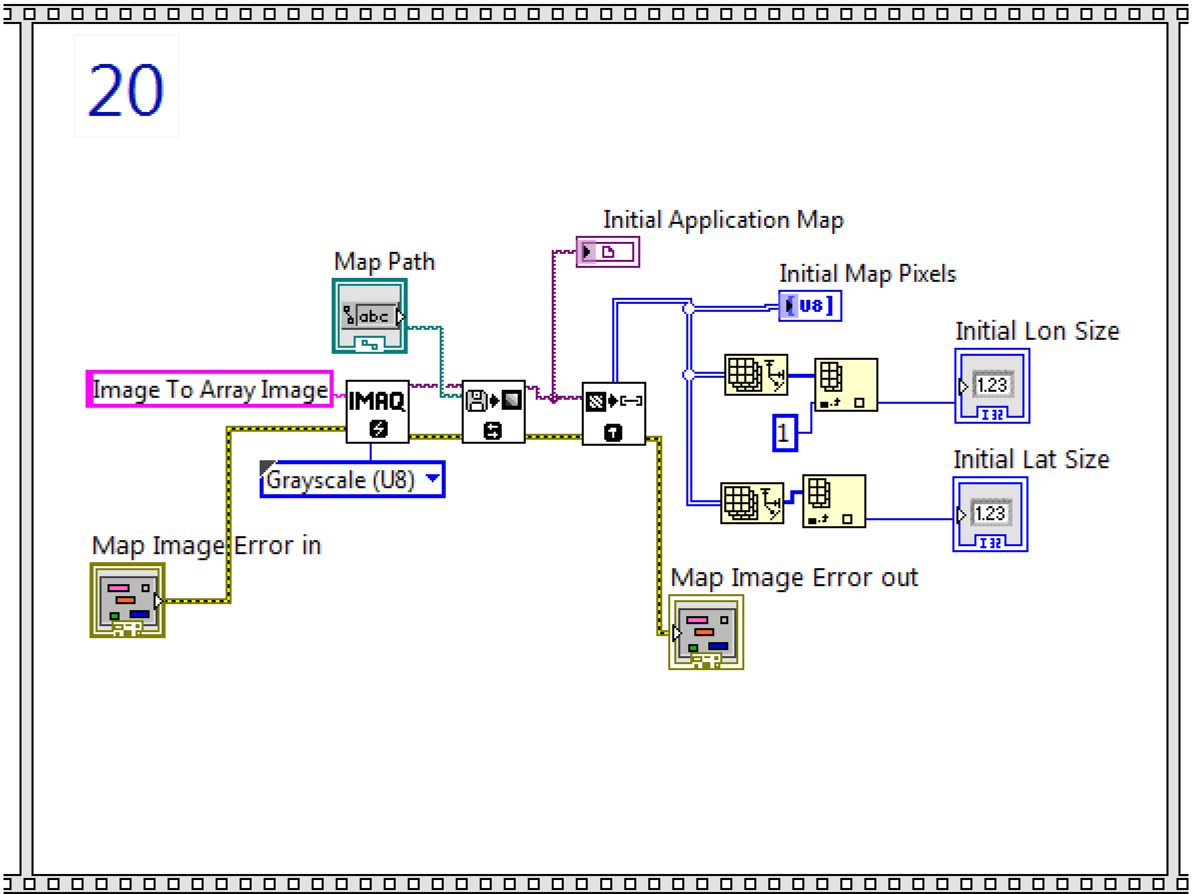
A21. Calculating comulating progress from the first row



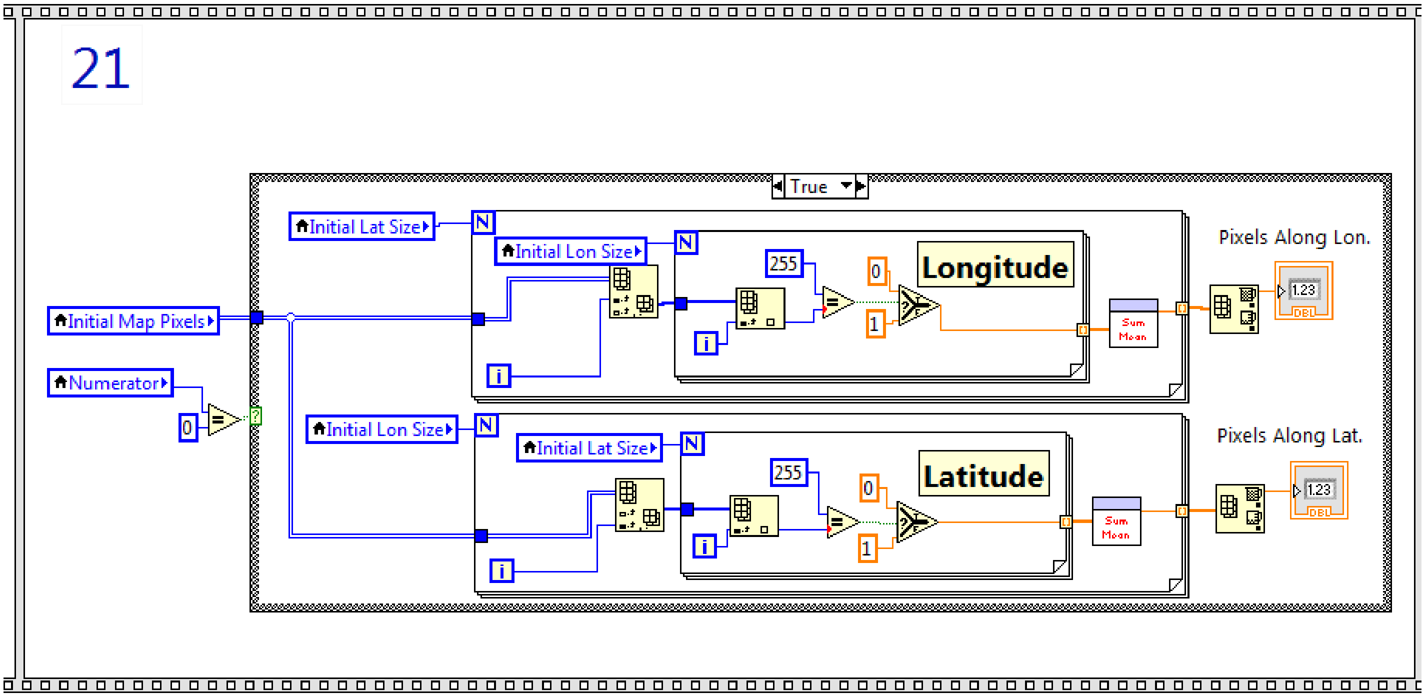
A22. Calculating the length of next travel run



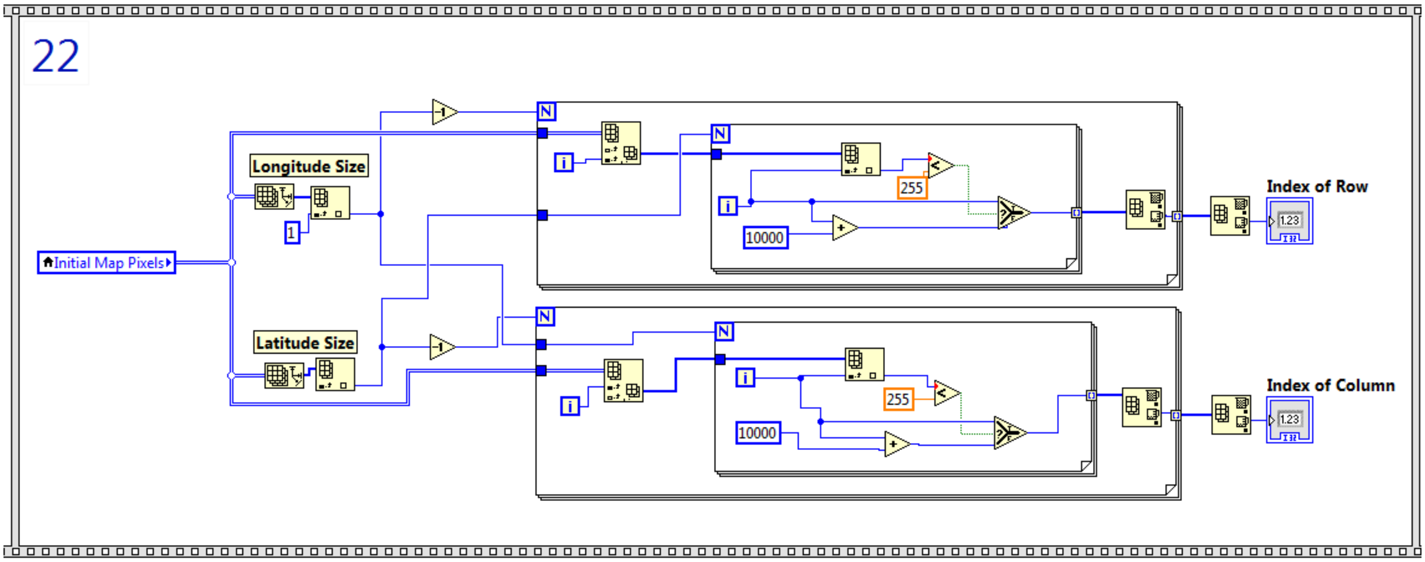
A23. Calculating the lateral distance of running row from the first row



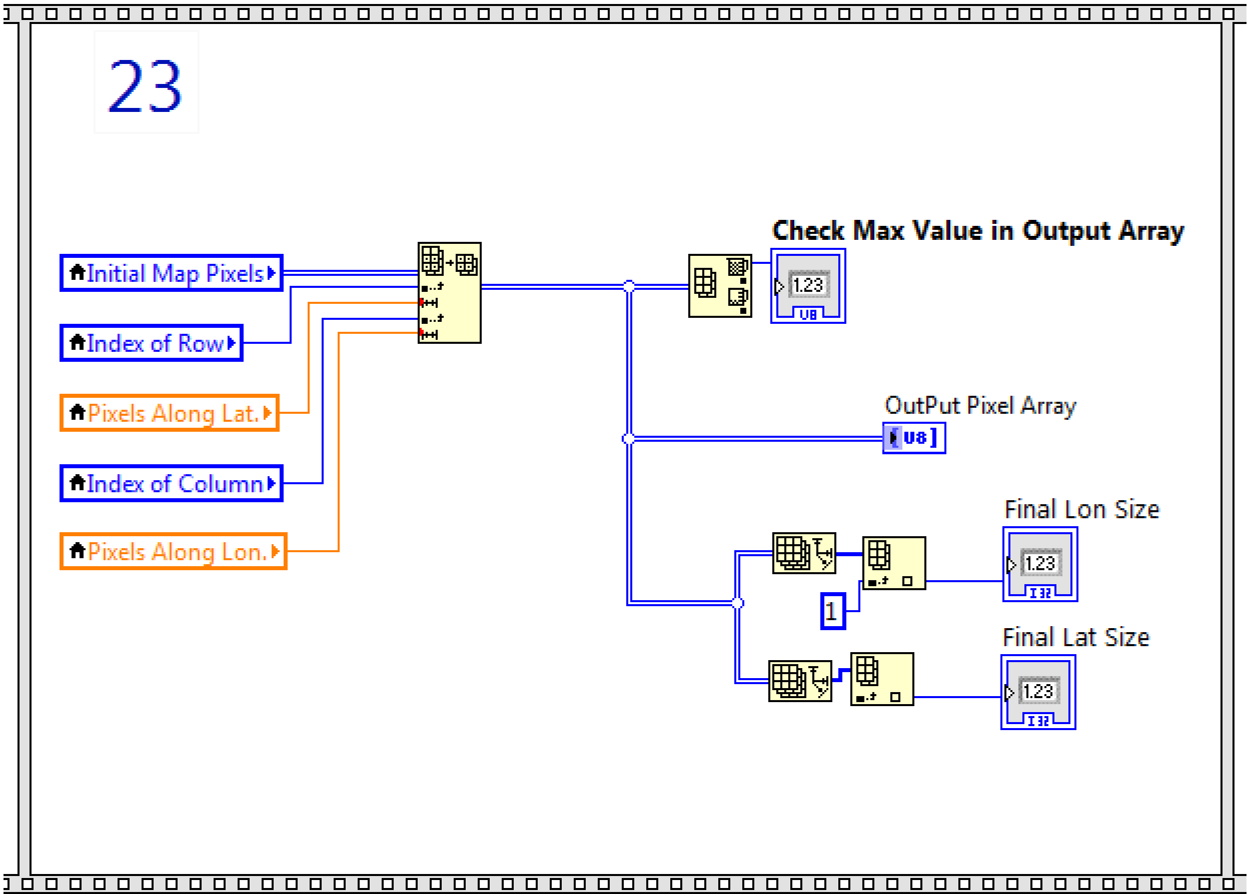
A24. Reading the map file image and calculating the size of the image array



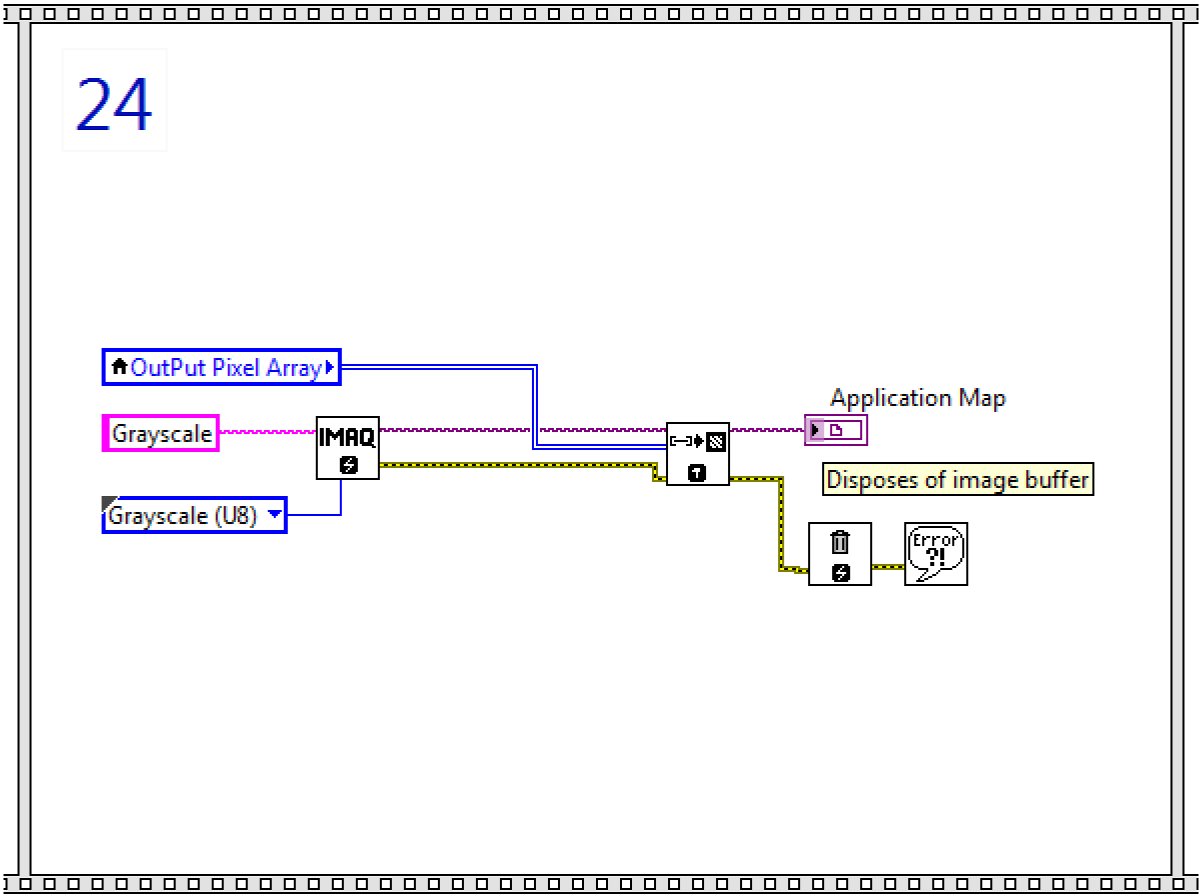
A25. Calculating the length and width of the map image in pixels



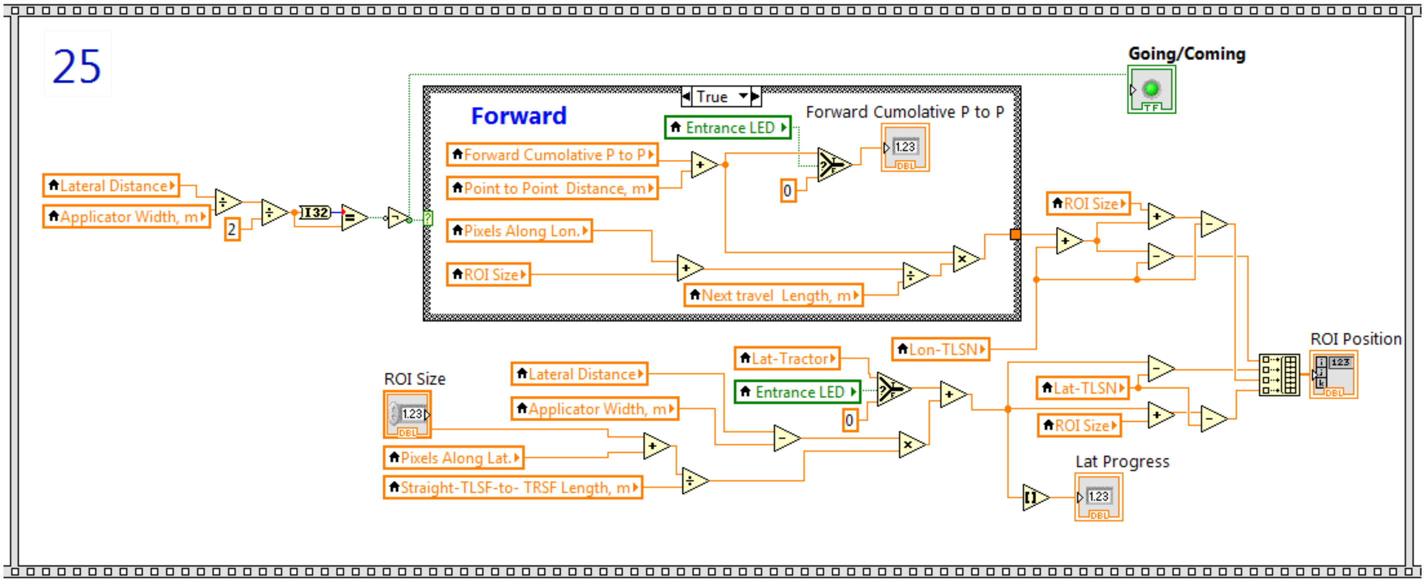
A26. Locating the first pixel index to remove white margin area around the map image



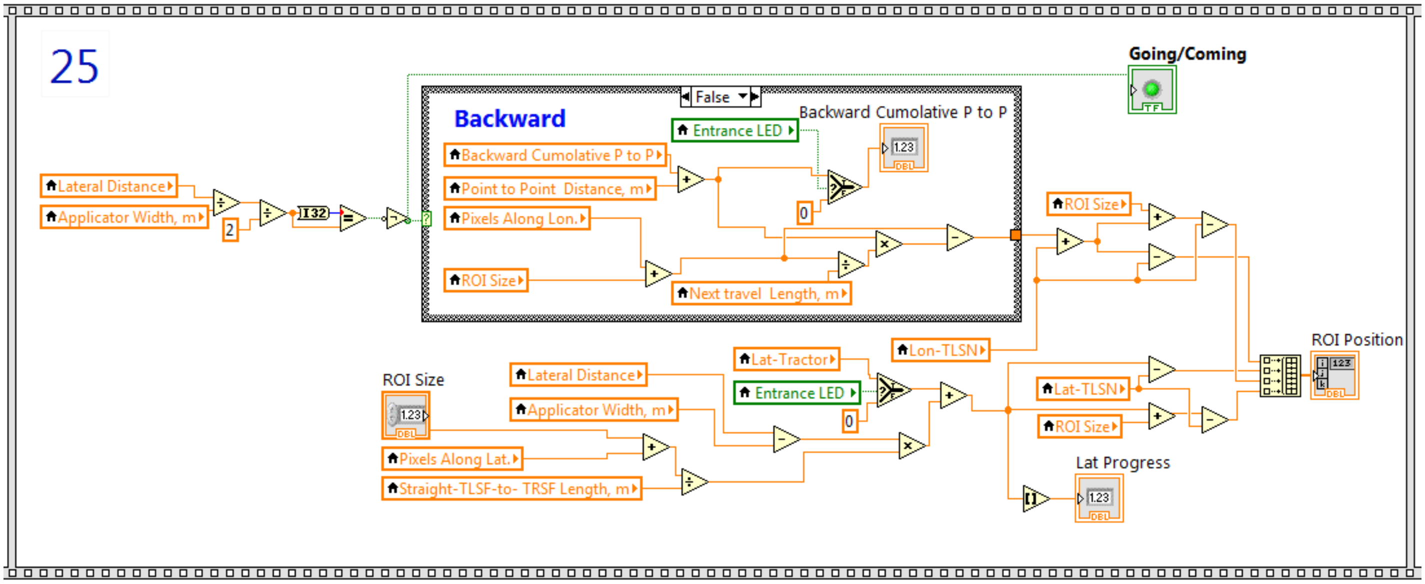
A27. Initiating the final map pixel which does not have white pixels



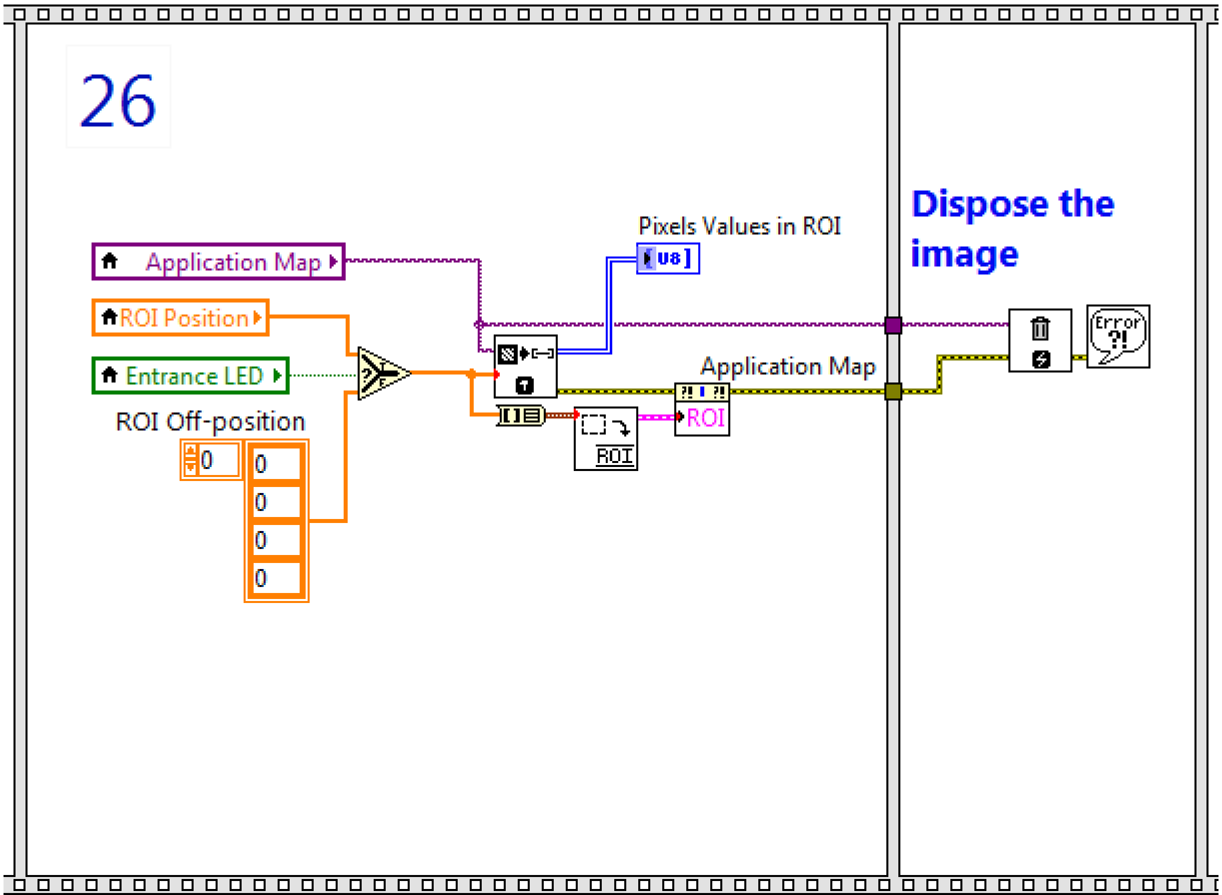
A28. Converting output array to filter map image



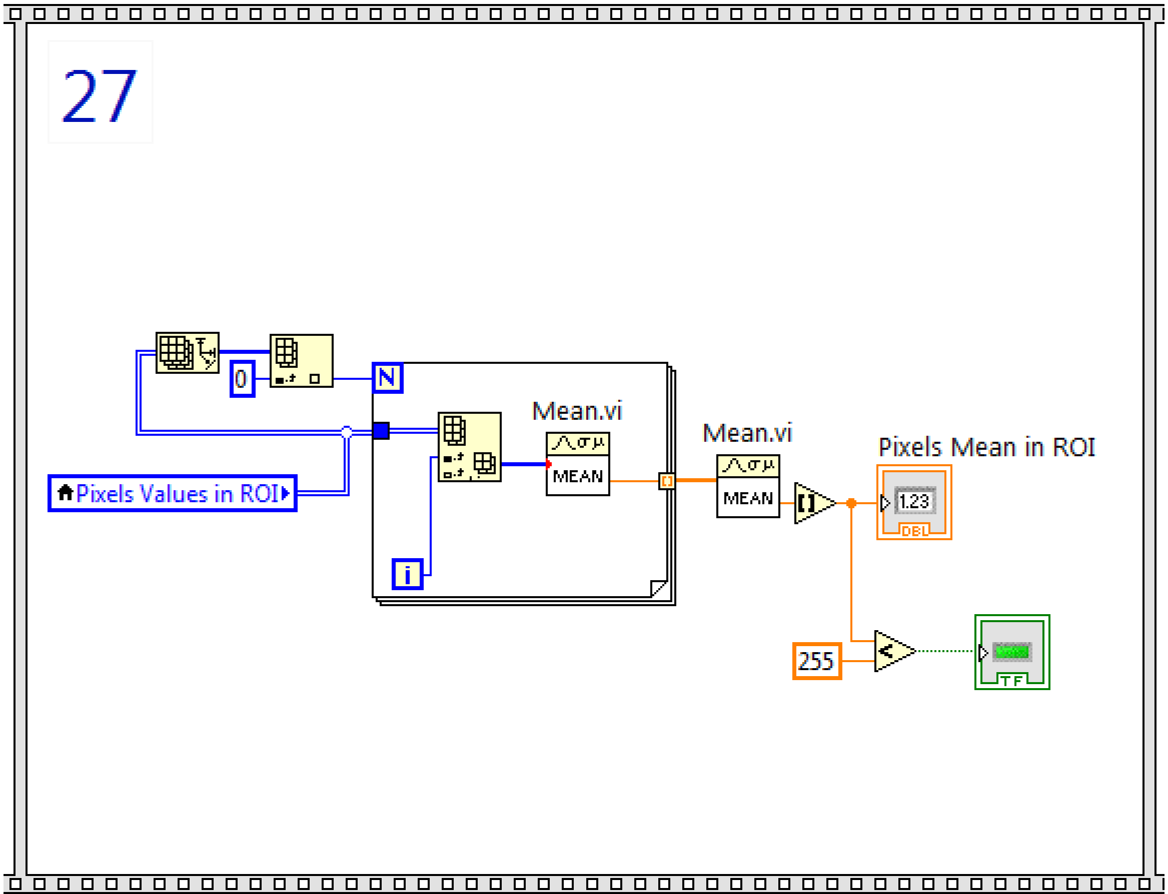
A29. Syncronizing the tractor and ROI movement in going



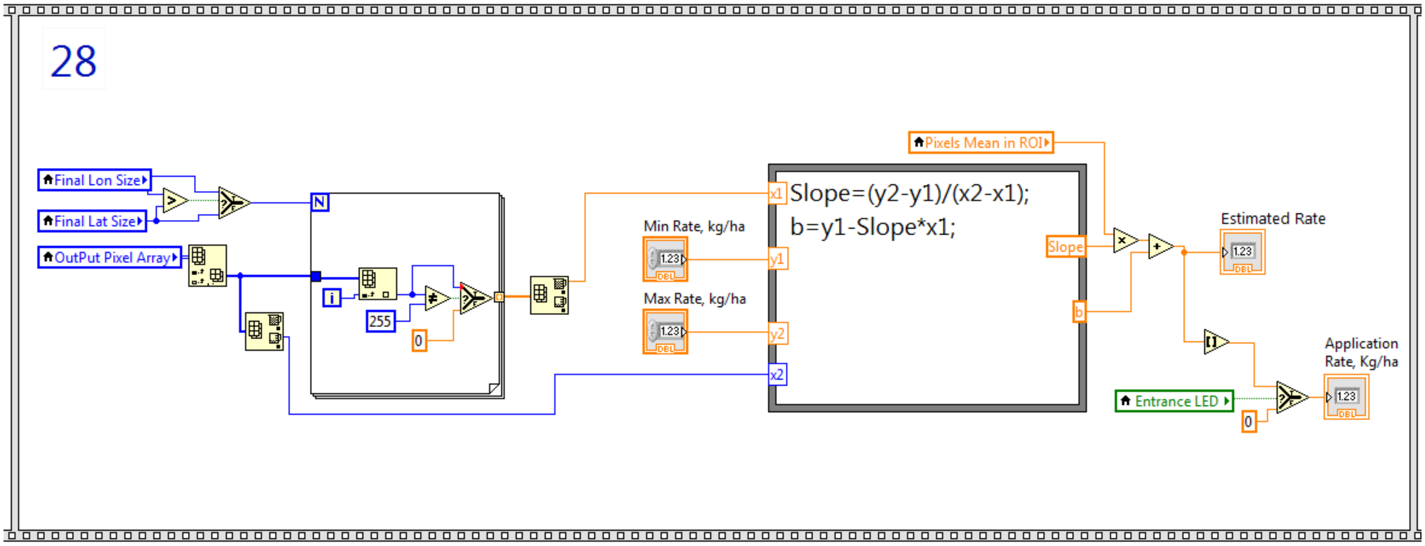
A30. Syncronizing the tractor and ROI movement in returning



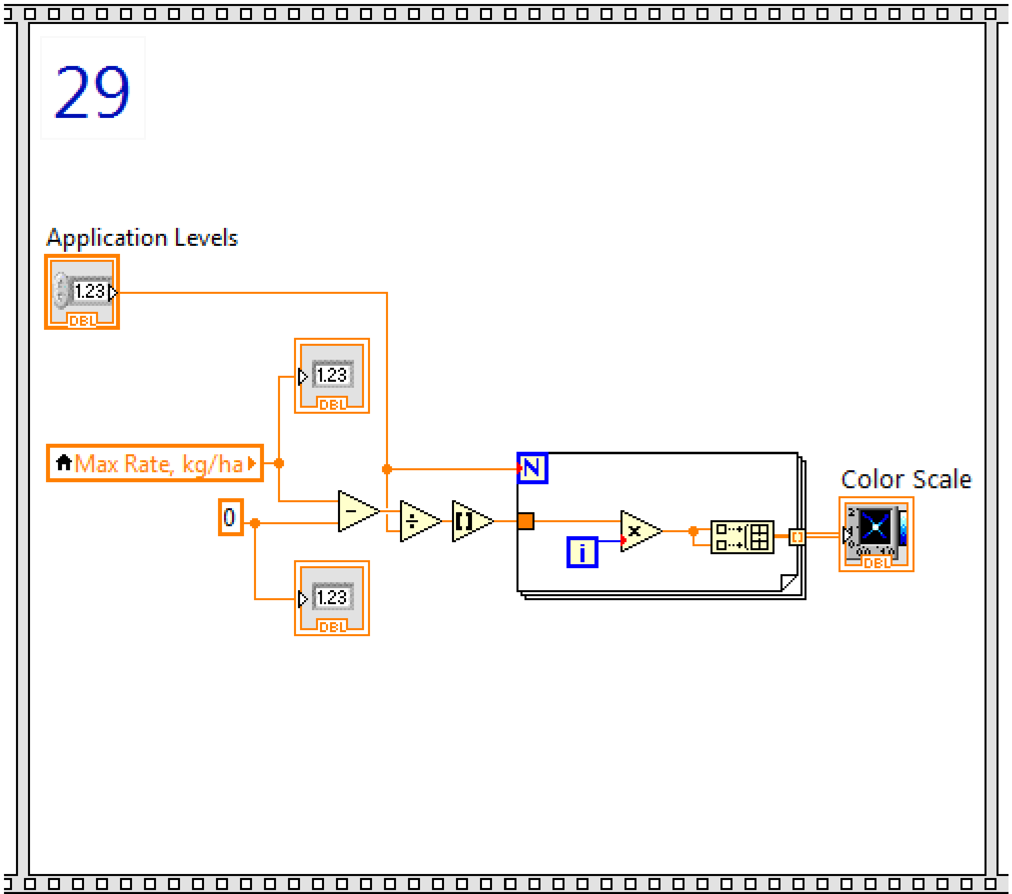
A31. Vissulizing the ROI on the graph



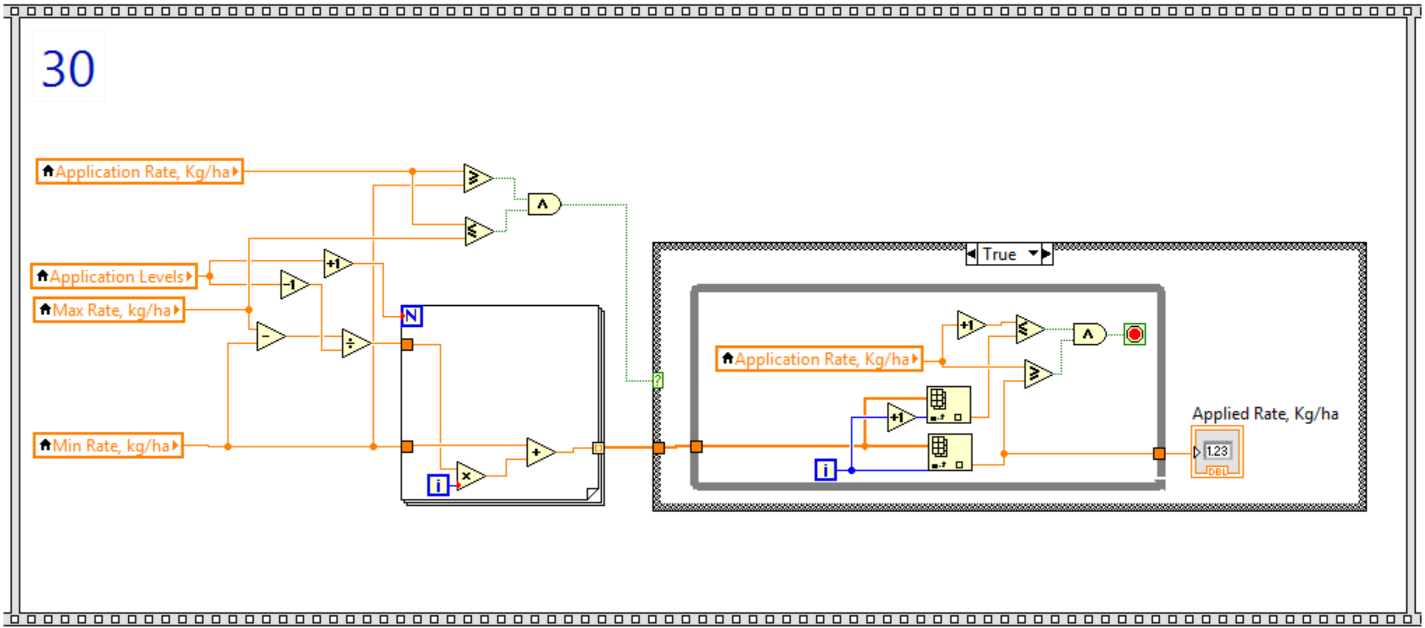
A32. Calculating the pixel average in ROI



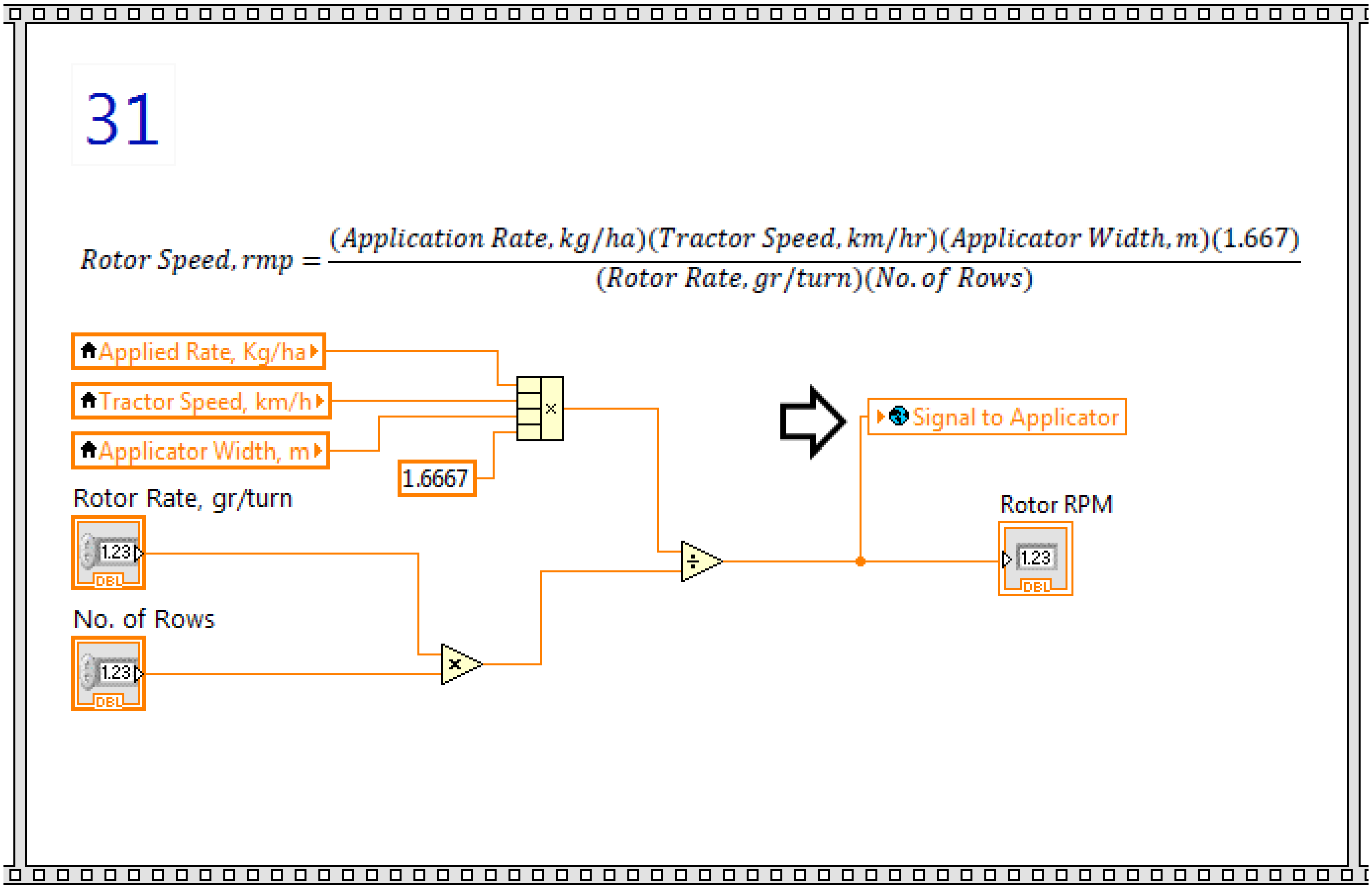
A33. Converting pixel average into the estimated fertilizer application based on the maximum and minimum application rates



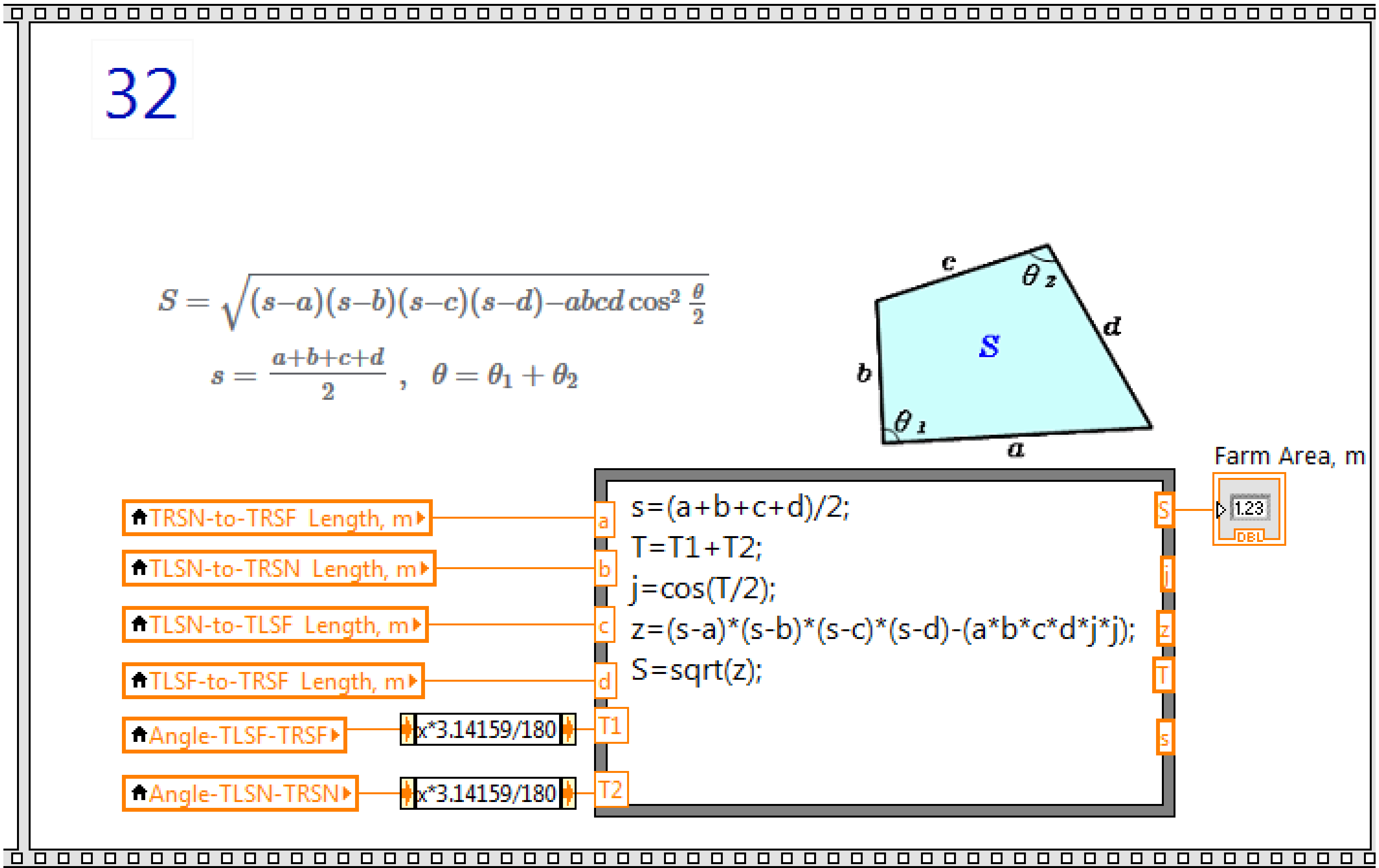
A34. Creating the active color bar



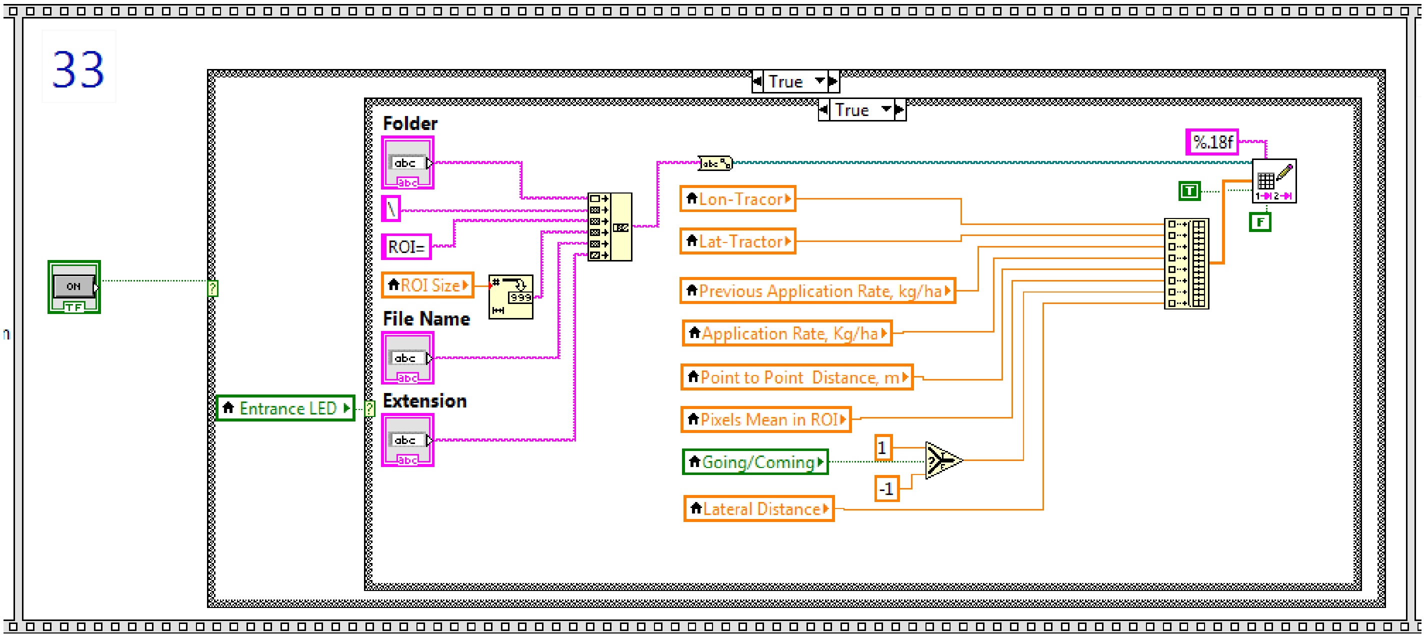
A35. Calculating fertilizer applied rate levels based on the color bar



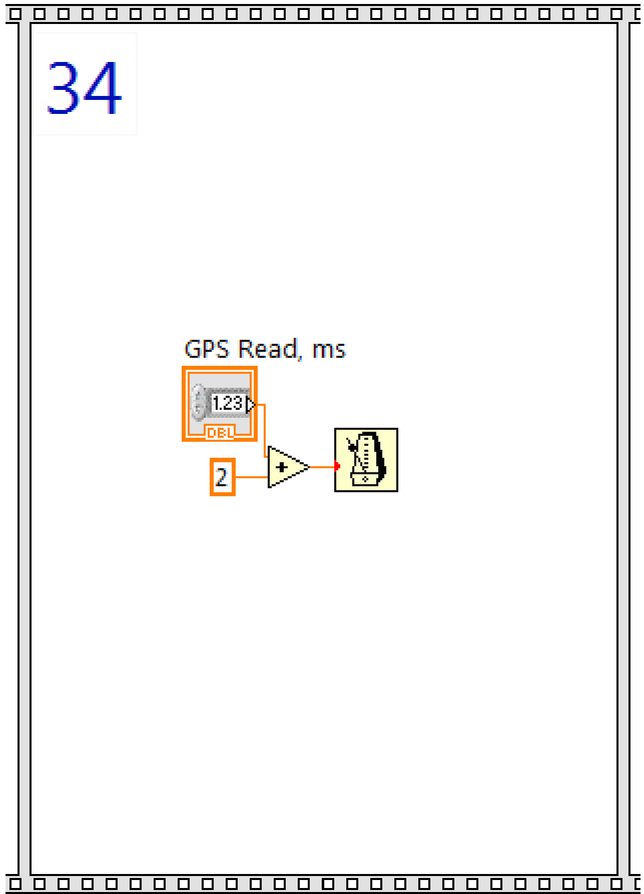
A36. Converting the applictaion to the signal for sending to the fertilizer applicator driver



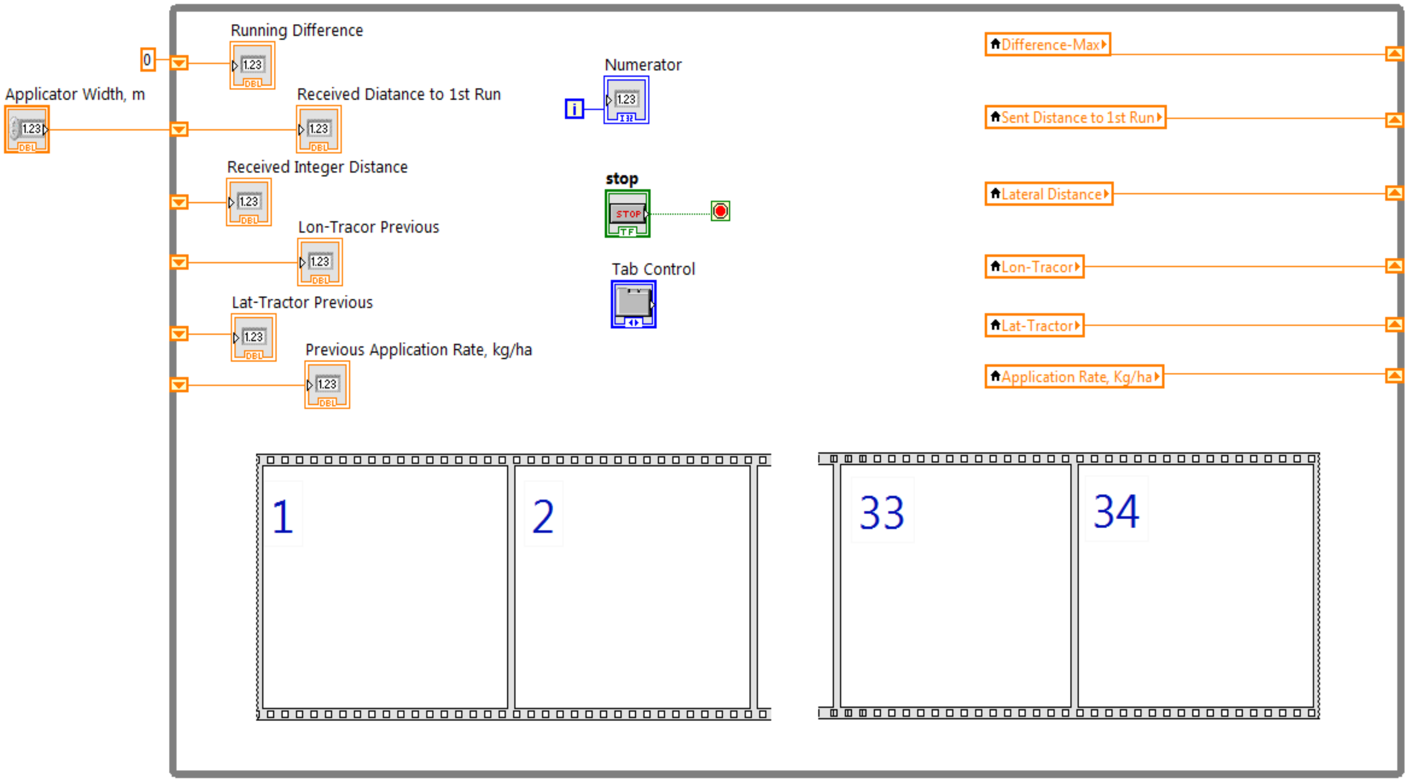
A37. Computing farm area based on the Bretschneider’s formula (right)



A38. Sending output data to Excel spreadsheet



A39. Adjusting the time required to receive tractor coordinates (right)



A40. The while loop structure to control the whole sequence structure