S1—1 Software logic

The objective of the following sections is to present the logic implemented in the software for each semi-automatic manipulation. First of all, some terms and intermediate steps will be defined. Then, the semi-automatic procedure for generating, merging and splitting droplet will be outlined in flow charts.

S1—1.1 Definitions

Channel The channel network is divided in arbitrary channels that are numbered and controlled independently, the positive direction is always towards the nearest junction.

Interface Identifies the droplet limit at the interface between oil and water.

Junction Defines the point at the intersection of three channels that is used for measurement.

Current position Defines the position $y_{current}$ where the interface is located within the channel with respect to the junction.

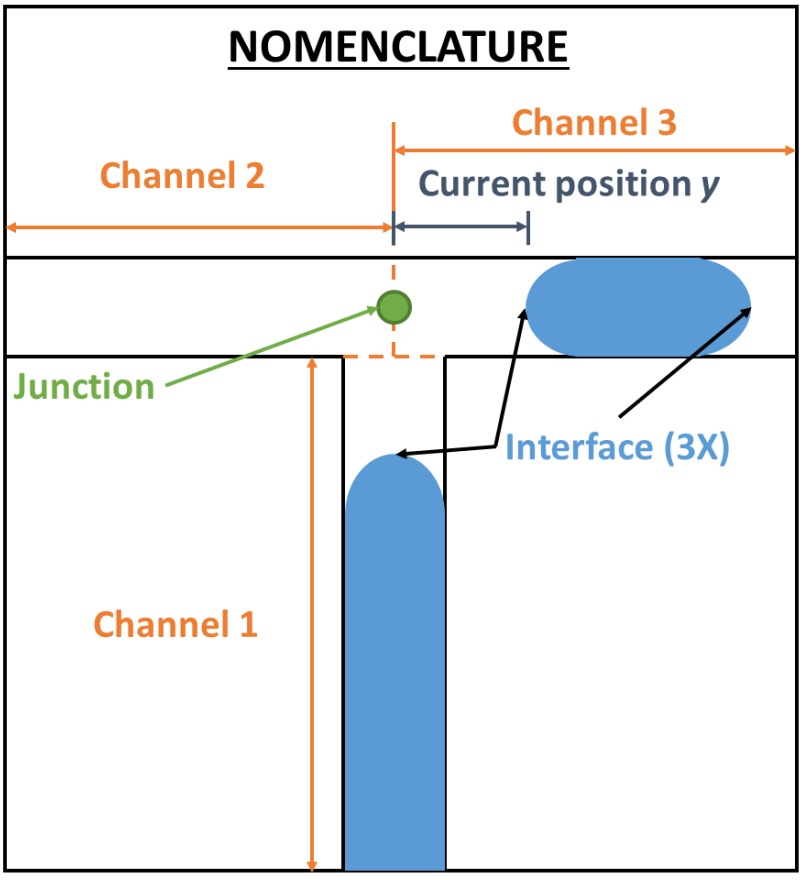

Figure S1—1.1: Definitions of elements to understand active droplet control.

S1—1.1.1 Legend

User input Includes any action that requires human intervention from the user through the graphical user interface (GUI).

Condition Defines a state for which specific condition(s) must be met (for instance, the position with respect to the tolerance) in order to progress to the next step.

Semi-automatic control Specifies a step implemented in the software with its general description.

Data Shows the flow of information (depending on the arrow direction), usually represents variables stored in memory that can also be displayed to the user.

S1—1.1.2 General

Parameter definition The user must define key parameter values (if different from default values) using the graphical user interface (GUI).

Tolerance (ϵ) Defines how close to the objective the current position must be before moving to the next step, limited by the resolution of microns per pixel.

Gains (K) Influences the dynamic response of how "fast" the interface reaches the objective position, e.g. K_{gain} in Equation 4.

Start the sequence Debut of the takeover of the semi-automatic algorithm over manual control initiated by the user.

Initial data storage Calculated and measured quantities based on the initial stage of the system when the sequence is initiated.

Link channels Synchronizes two channels such that they move in unison.

Reverse link channels Links the displacement in two channels such that they move in opposite directions.

Split and move away From reverse link of the two appropriate channels, moving in opposite direction leads to the formation of two new interface; the motion away from the junction is implemented to prevent the accidental merging back of the two new interfaces.

Wait to stabilize A delay is implemented such that the droplet(s) can stabilize at their respective location.

Stabilized result droplet(s) No change in the desired droplet position, immobilization of the droplet(s) of interest for accurate measurement.

S1—1.1.3 Specific to droplet generation

Desired droplet length [μm] User-specified droplet length to be generated.

Distance to junction Scaled measurement between the interface and the junction point.

Move towards junction The interface is moved towards the junction such that the dispersed phase overflows in the adjacent channels to the junction.

Interface selection in new channel The user must select (using the mouse) the interface in either of the adjacent channels for which the length will be adjusted.

Adjust droplet length The distance between the interface and the junction is matched to the desired droplet length within the specified tolerance.

Droplet length Output of the length of the droplet generated as per the micron per pixel scaling.

S1—1.1.4 Specific to droplet merging

Droplet closest to junction The interface of one of the two droplet that is measured closest to the point defining the junction.

Droplet furthest from junction As opposed to the droplet closest to junction, the interface that is furthest from the junction as per the initial measurements.

Droplets equidistant from junction The interface of both droplets at an equal distance from the junction in their respective channel.

No more initial droplet interface The two initial interface have merged and as such do not exist anymore.

S1—1.1.5 Specific to droplet splitting

Desired droplet ratio [%] User-specified droplet ratio to be obtained from the two resulting droplets.

Initial ratio Calculated from the initial state of the system.

Distance to move Calculated based on the desired ratio and current state of the system.

Adjust droplet ratio The distance between one of the interface and the objective position is matched within the specified tolerance.

Droplet ratio [%] Ratio based on the measurements of the two droplets obtained at the end of the procedure.

S1—1.2 Droplet generation

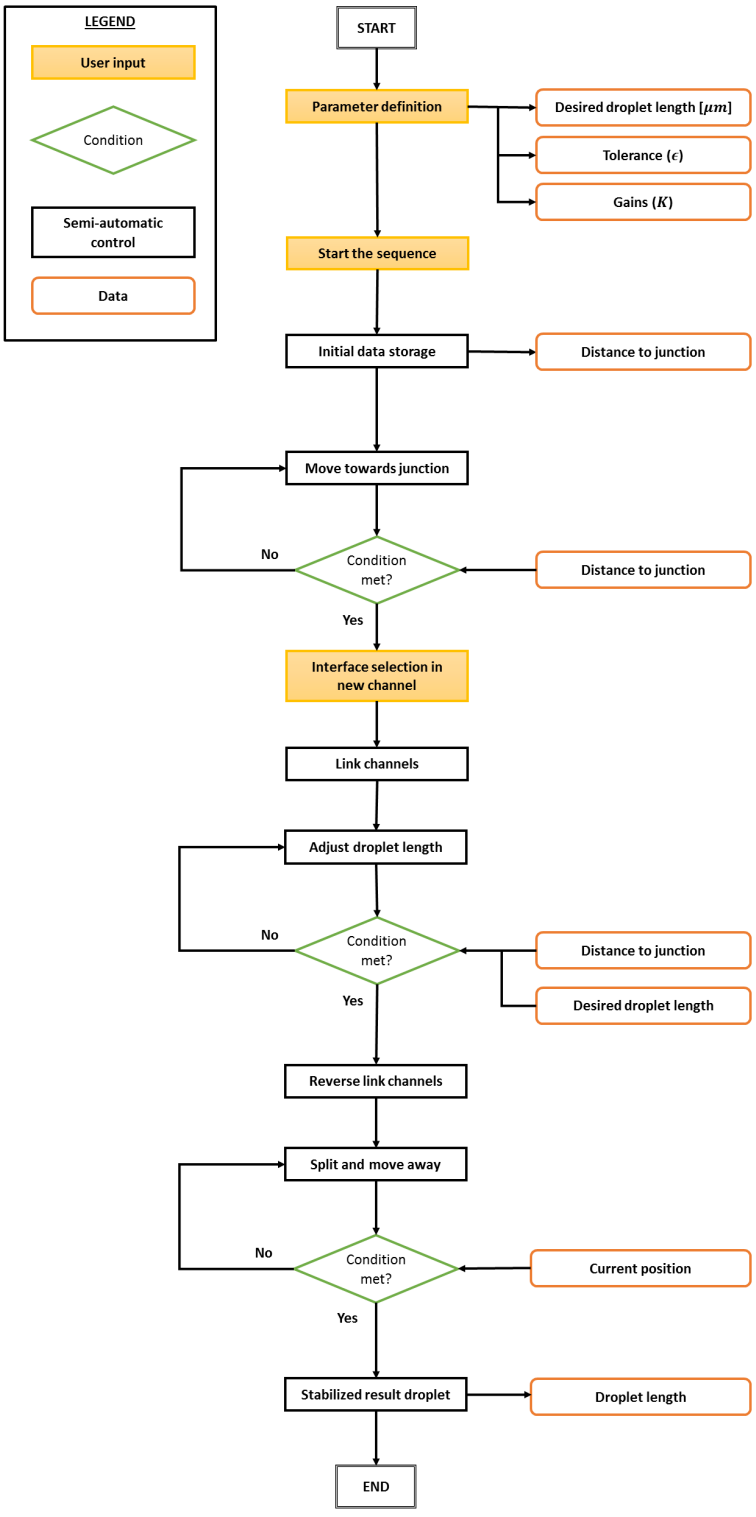

Figure S1—1.2: Flow chart for generation of a droplet of a specified length.

S1—1.3 Droplet merging

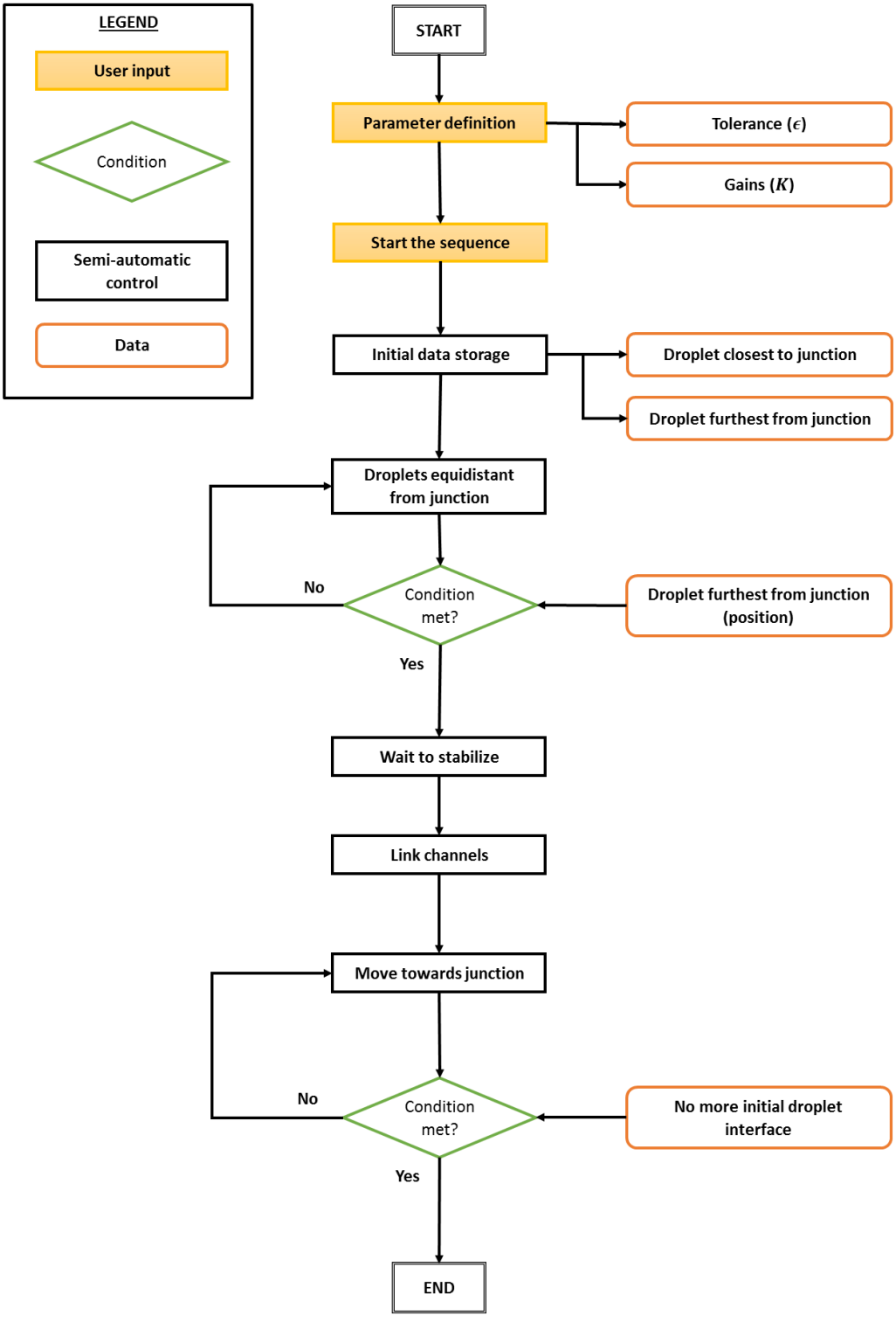

Figure S1—1.3: Flow chart for merging of two droplets.

S1—1.4 Droplet splitting

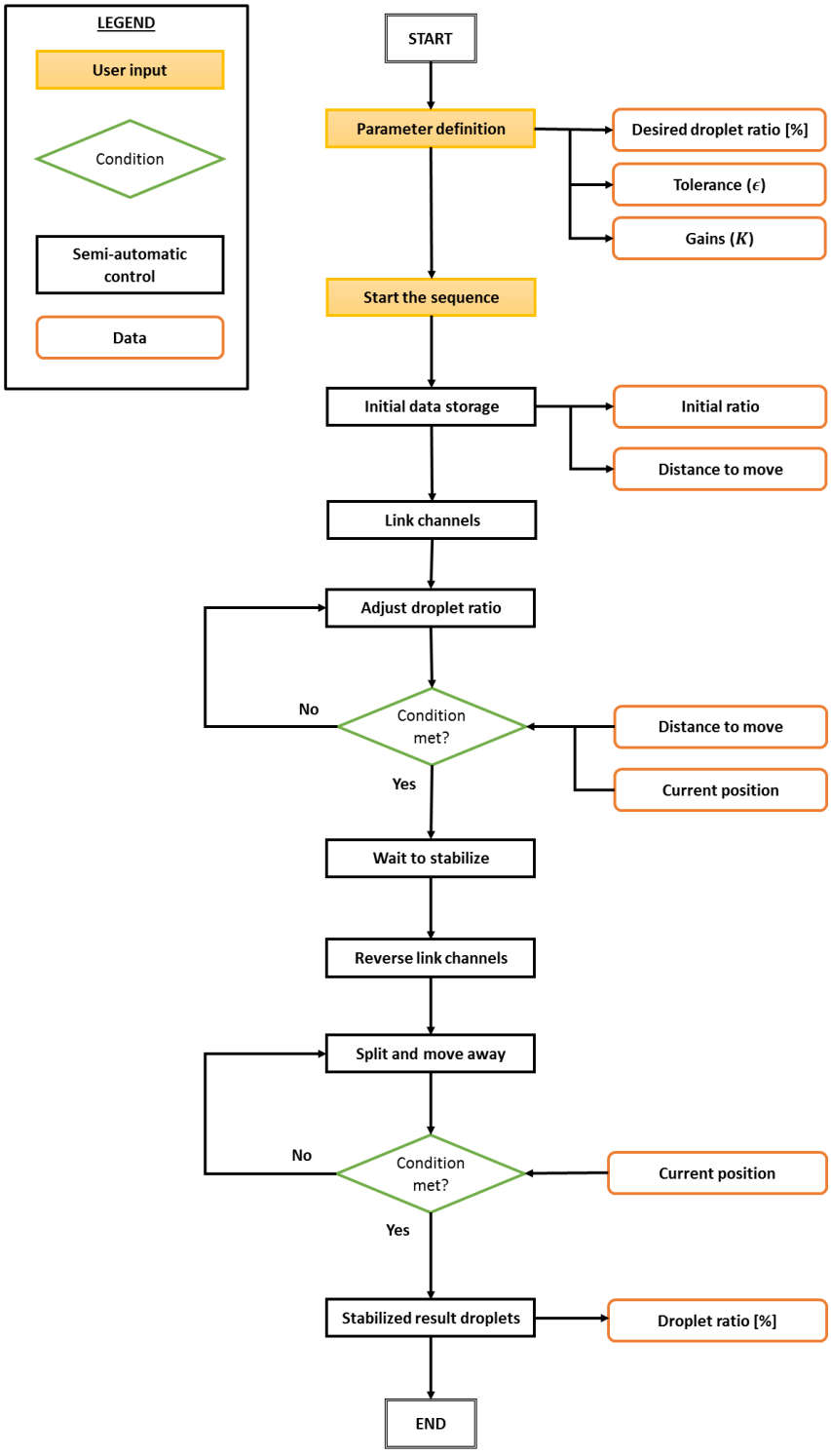

Figure S1—1.4: Flow chart for splitting of a droplet at a specified ratio.