

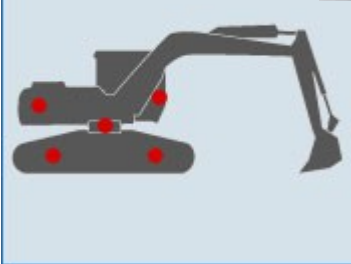
Testing high-power hydraulic pumps with NI LabVIEW (RT) and the StateChart module

Jeffrey Habets & Roger Custers
www.vi-tech.nl

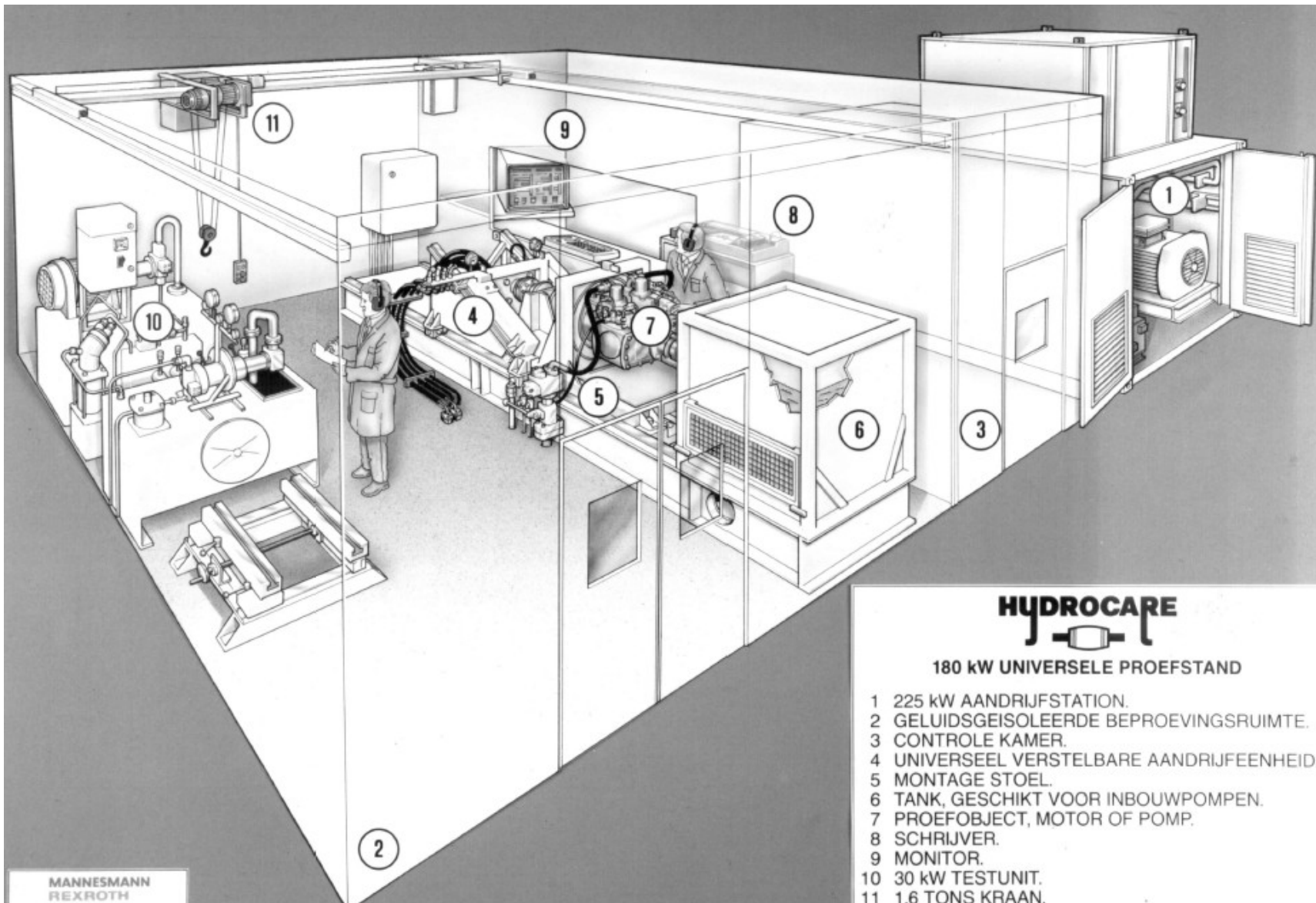
Agenda

- Introduction to the teststand
- The challenge
- New setup – system overview
- Windows application – User Interface
- RT application
- Statecharts – steam course!
- RT application – Statechart
- Conclusions....
- Resources

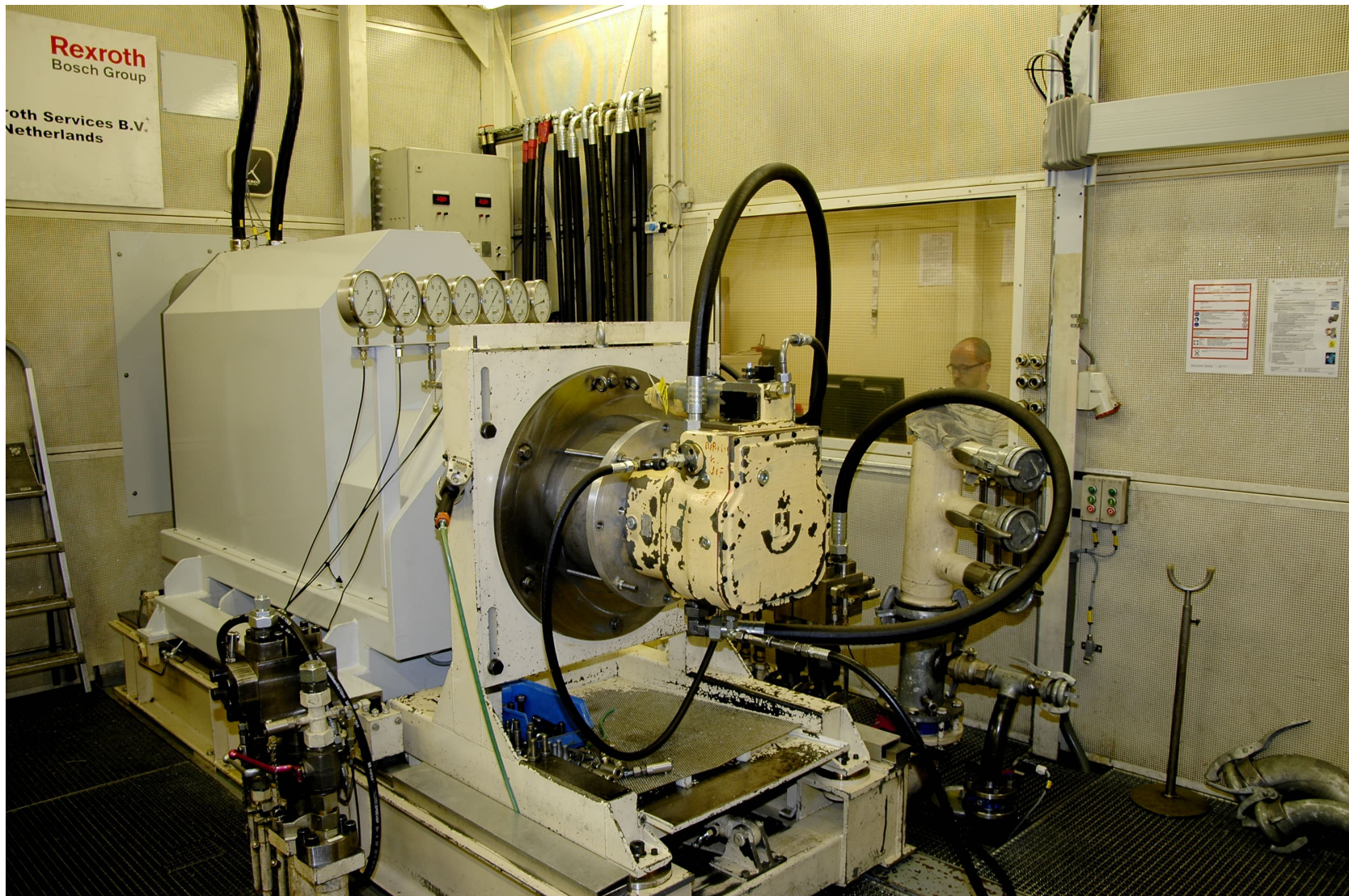
Introduction – Hydraulic pumps usage



Introduction – Physical setup

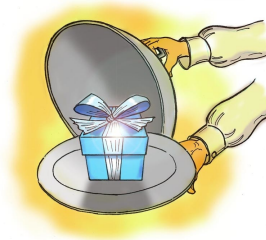


Introduction - Pump test chamber

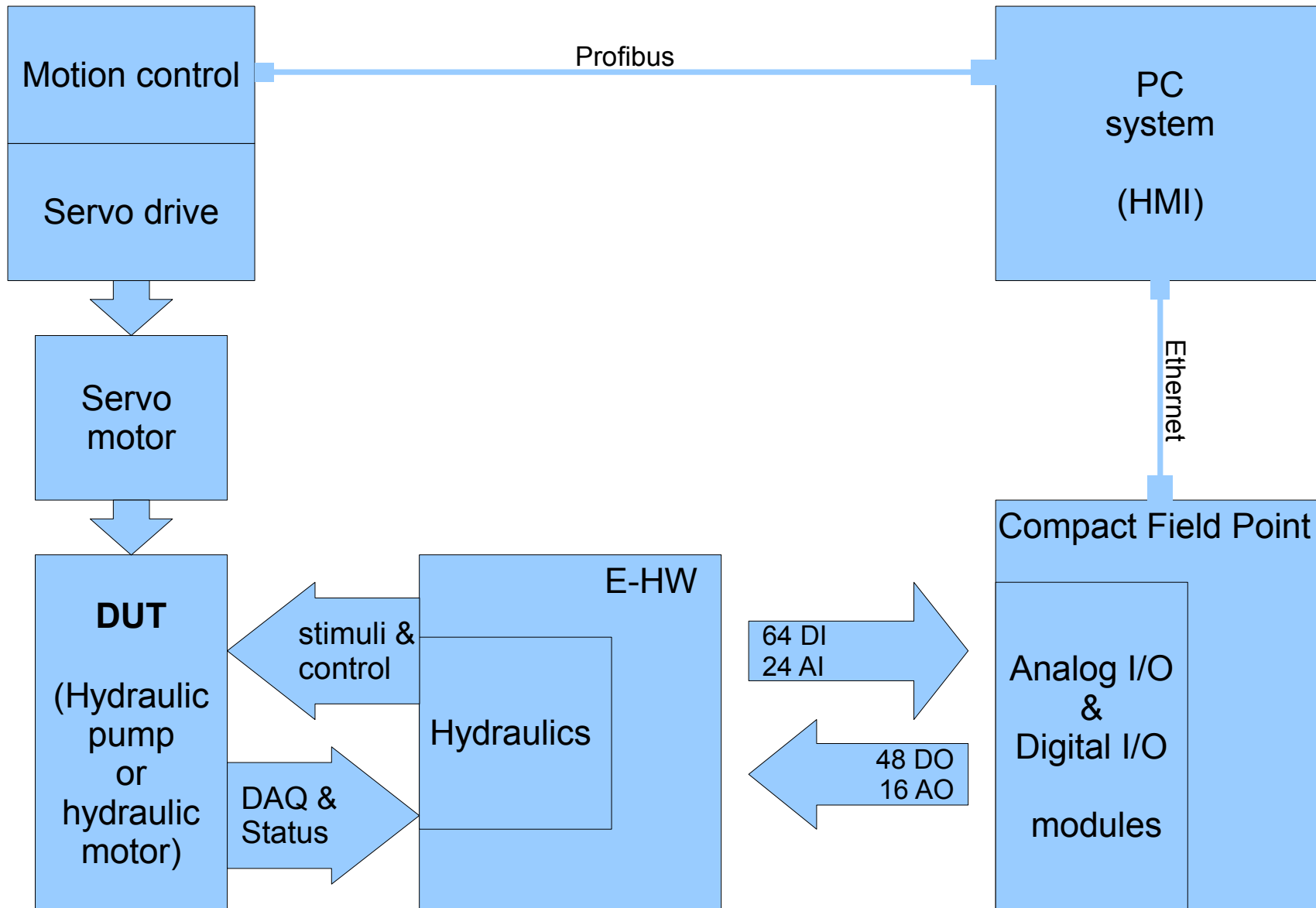


The challenge

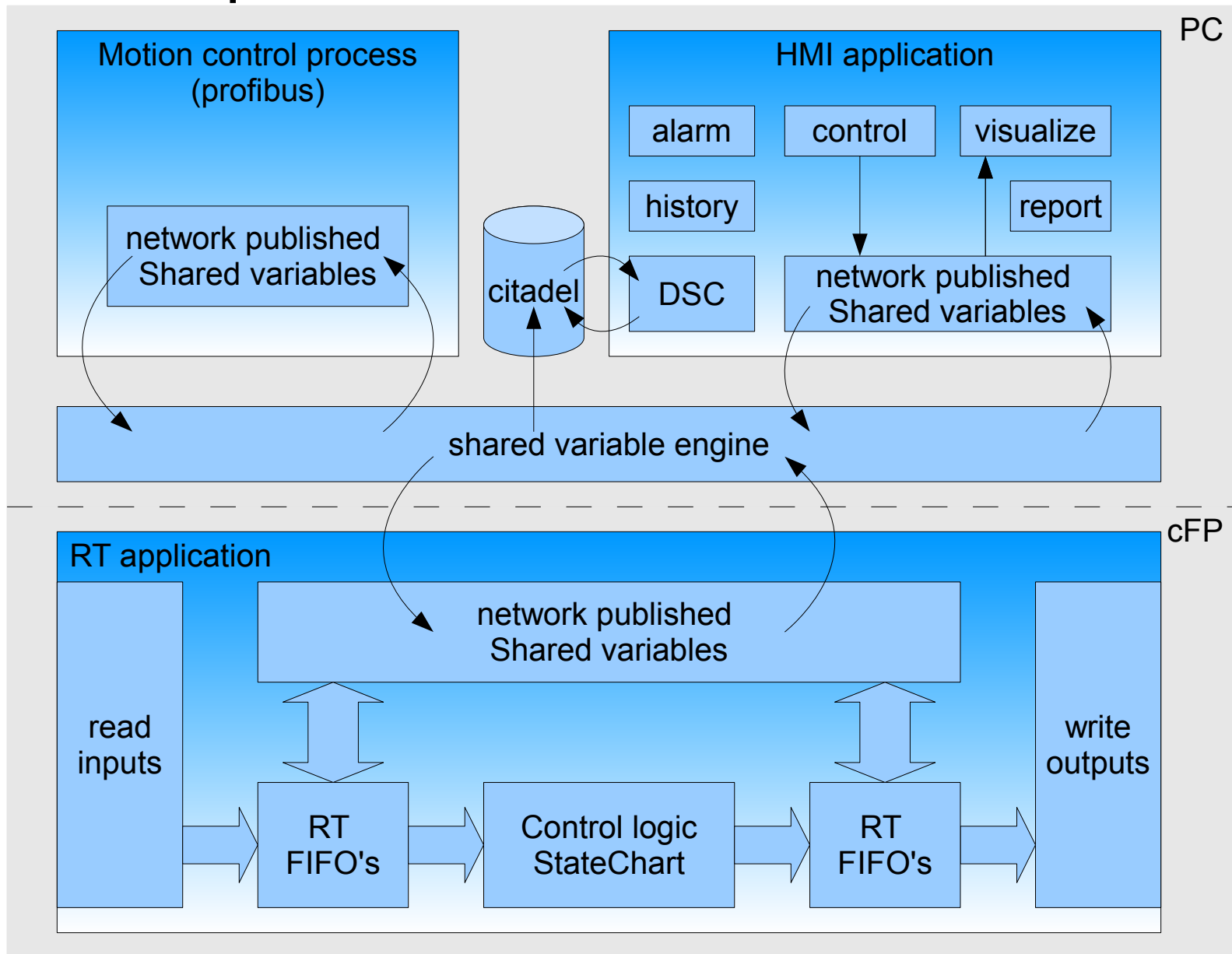
- Design, implement, integrate and going live within 8 weeks ...
- During implementation and integration: new requirements
- Hydraulic drive motor is replaced by an electric 250kW motor controlled by a Bosch Rexroth Indradrive
- PLC is replaced by a cFP controller with an LV RT application
- Several stand-alone data-acquisition units that where used to record measurement data are replaced by doing DAQ via cFP
- System operable by more than just the guy who created it and knows all ins and outs
- The State Chart is your best friend !



New setup – system overview



New setup – Software overview



Windows app - User interface

PCApplication.lvlib:PCMain.vi

maandag 26 september 2011 00:14:27

opgetreden	Prioriteit	locatie	beschrijving

Alles stop

Meldingen Overzicht Input Beproeving Rapport generatie I/O Overzicht

Alarmen overzicht

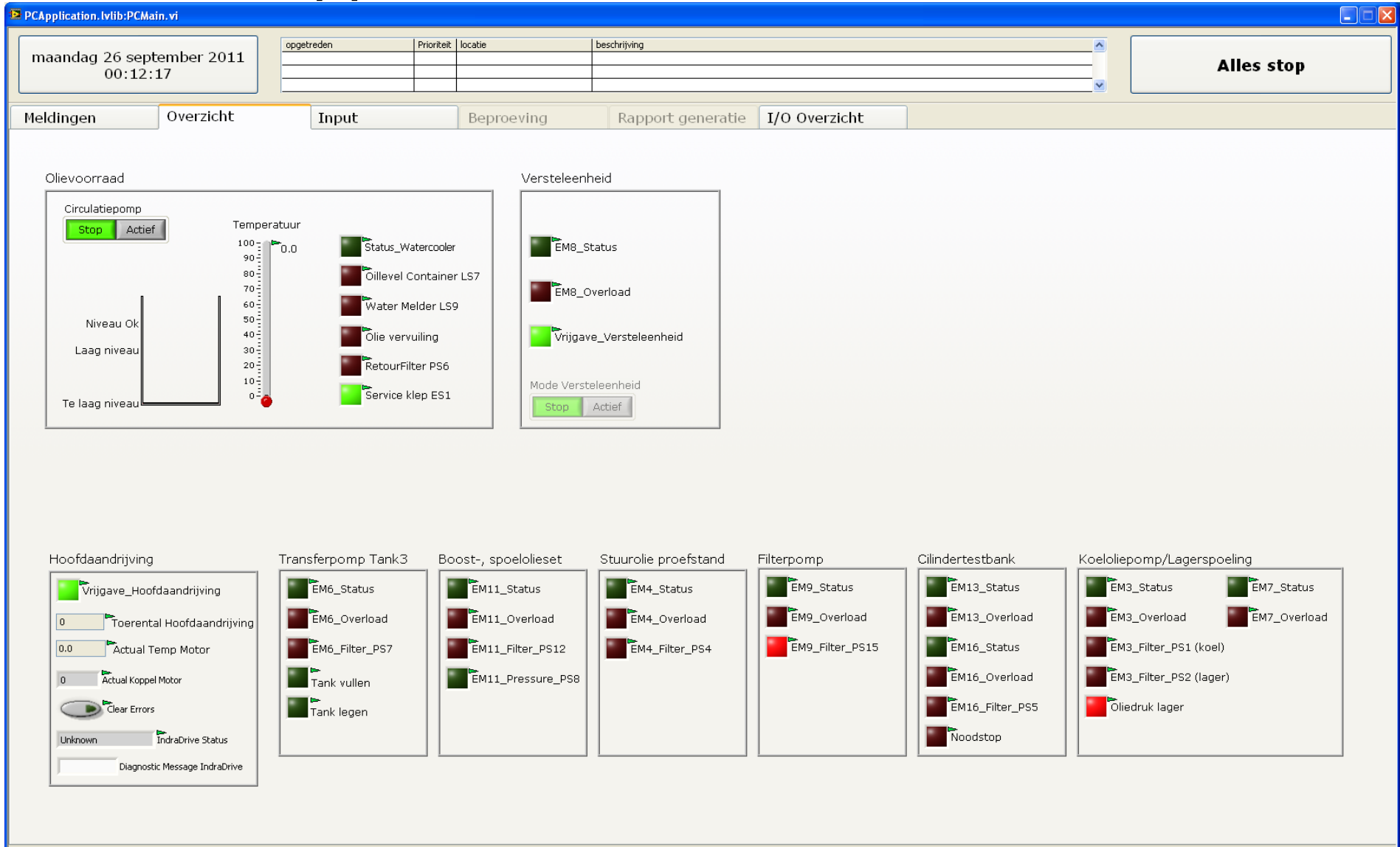
URL

Refresh 1 Days

URL	opgetreden	Prioriteit	locatie	beschrijving
{\change1\SharedVariableLibs\CompositeAlarms\LV_Error.Alarms.Boolean	09/26/2011 00:08:48	400		Field Point Error
{\change1\SharedVariableLibs\DigitalIn\1_2_18_DI TANK 3 OIL LEVEL HIGH LS8.Alarms.Boolean	09/26/2011 00:08:01	100	Tank3	Tank 3 hoog niveau
{\change1\SharedVariableLibs\DigitalIn\1_2_17_DI TANK 3 OIL LEVEL LOW LS2.Alarms.Boolean	09/26/2011 00:08:01	200	Tank3	Tank 3 kritiek niveau
{\change1\SharedVariableLibs\DigitalIn\1_2_12_DI PS8 BOOSTPRESS.LOW EM11'.Alarms.Boolean	09/26/2011 00:08:01	100	StuurSpoelOlieset	Onvoldoende druk SpoelOlie
{\change1\SharedVariableLibs\FP2HostCom\038 cFP_Error.Alarms.Boolean	09/26/2011 00:08:00	300		
{\change1\SharedVariableLibs\DigitalIn\1_2_18_DI TANK 3 OIL LEVEL HIGH LS8.Alarms.Boolean	09/26/2011 00:03:02	100	Tank3	Tank 3 hoog niveau
{\change1\SharedVariableLibs\DigitalIn\1_2_17_DI TANK 3 OIL LEVEL LOW LS2.Alarms.Boolean	09/26/2011 00:03:02	200	Tank3	Tank 3 kritiek niveau
{\change1\SharedVariableLibs\DigitalIn\1_2_12_DI PS8 BOOSTPRESS.LOW EM11'.Alarms.Boolean	09/26/2011 00:03:02	100	StuurSpoelOlieset	Onvoldoende druk SpoelOlie
{\change1\SharedVariableLibs\CompositeAlarms\LV_Error.Alarms.Boolean	09/25/2011 14:55:47	400		Error -1950679035 occurred at Shared
{\change1\SharedVariableLibs\CompositeAlarms\LV_Error.Alarms.Boolean	09/25/2011 14:40:12	400		Error -1073807343 occurred at General
{\change1\SharedVariableLibs\DigitalIn\1_2_18_DI TANK 3 OIL LEVEL HIGH LS8.Alarms.Boolean	09/25/2011 14:17:59	100	Tank3	Tank 3 hoog niveau
{\change1\SharedVariableLibs\DigitalIn\1_2_17_DI TANK 3 OIL LEVEL LOW LS2.Alarms.Boolean	09/25/2011 14:17:59	200	Tank3	Tank 3 kritiek niveau
{\change1\SharedVariableLibs\DigitalIn\1_2_12_DI PS8 BOOSTPRESS.LOW EM11'.Alarms.Boolean	09/25/2011 14:17:58	100	StuurSpoelOlieset	Onvoldoende druk SpoelOlie

bevestig alarmen Alarm historie

Windows app - User interface



Windows app - User interface

PCApplication.lvlib:PCMain.vi

maandag 26 september 2011 00:14:56

opgetreden	Prioriteit	locatie	beschrijving

Alles stop

Meldingen Overzicht **Input** Beproeving Rapport generatie I/O Overzicht

Systeem

- ☐ Stop
- ☐ Open systeem
- ☒ Gesloten systeem
- ☐ Tankinbouw open systeem
- ☐ Tankinbouw gesloten systeem
- ☐ Gesloten systeem eigen voeding

Aandrijving

- ☐ Stop
- ☐ Actief linksom
- ☒ Actief rechtsom
- Maximaal Toerental: 1000 Omw/min
- Maximaal Koppel: 1000 Nm
- ☐ Diesel simulatie
- Maximaal Vermogen: 50 kW

Belasting 1

- ☐ Stop
- ☐ Direct
- ☐ Indirect
- ☒ Direct & indirect

Belasting 2

- ☒ Stop
- ☐ Actief

Aansturing

- ☐ Stop
- ☐ Elektrisch
- ☒ Hydraulisch
- ☐ Elektrisch & Hydraulisch
- ☒ Geen
- ☐ Kaart 1 (VT-VCPA1)
- ☐ Kaart 2 (VT-VSPA2)
- ☐ Kaart 3 (VT5035)
- ☐ Kaart 4 (VT5036)
- ☐ Kaart 5 (5041)
- ☐ Kaart 6 (VT1610)
- ☐ Kaart 7 (SR7)

Metingen

Sample snelheid: 10 samples / sec

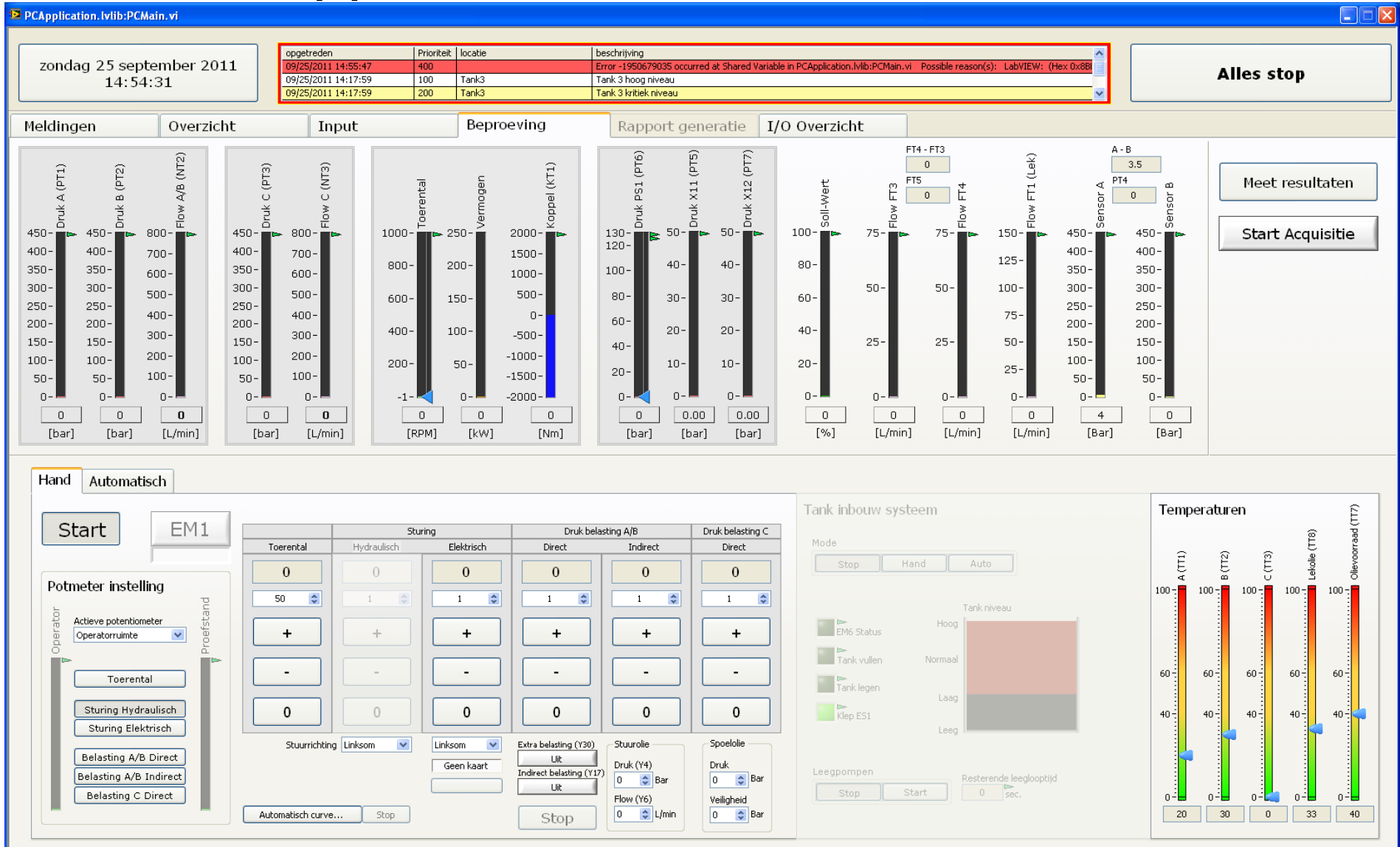
Losse sensor A range: Min 0 Bar, Max 450 Bar

Losse sensor B range: Min 0 Bar, Max 450 Bar

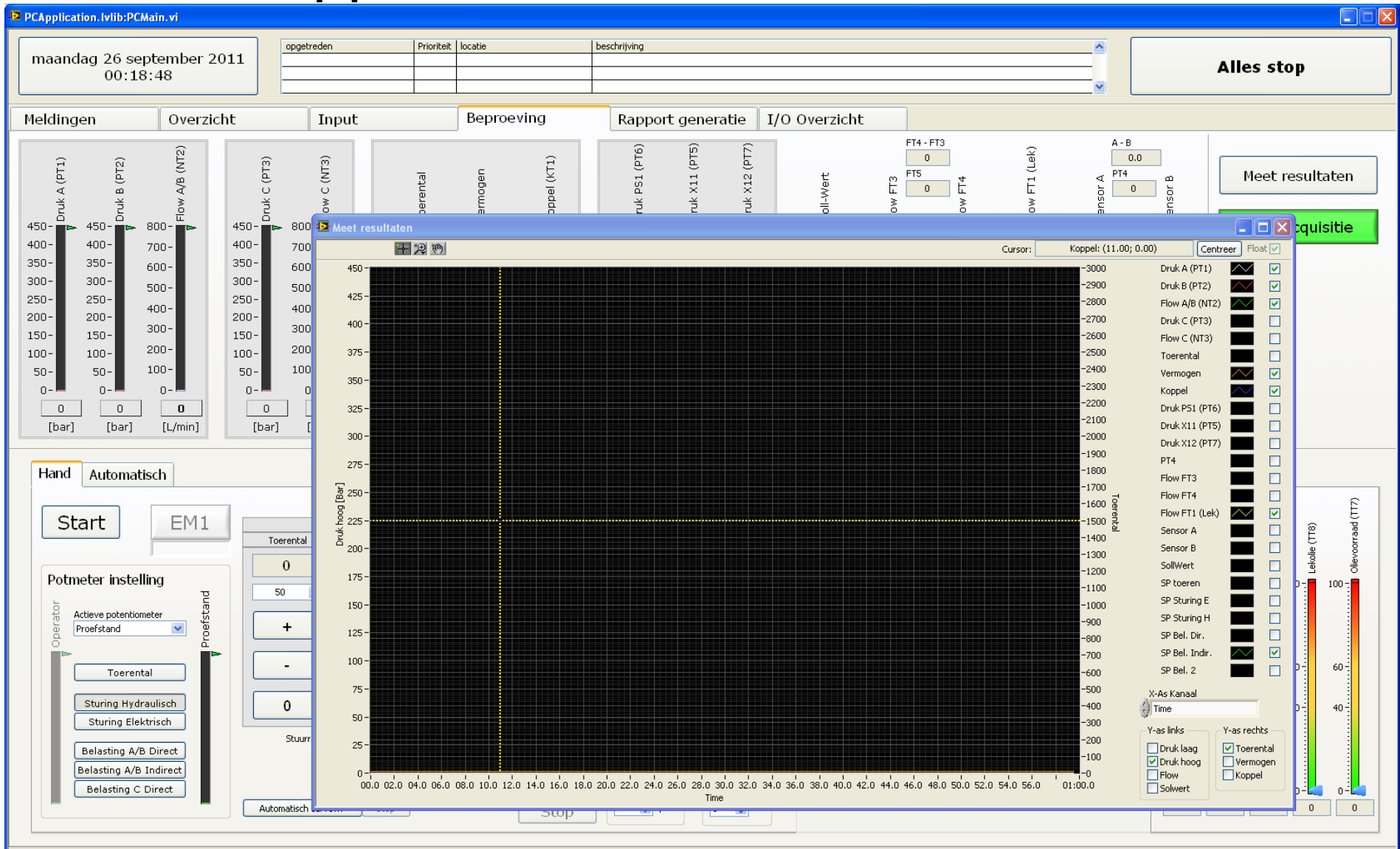
Losse sensor PT4 range: Min 0 Bar, Max 450 Bar

Start

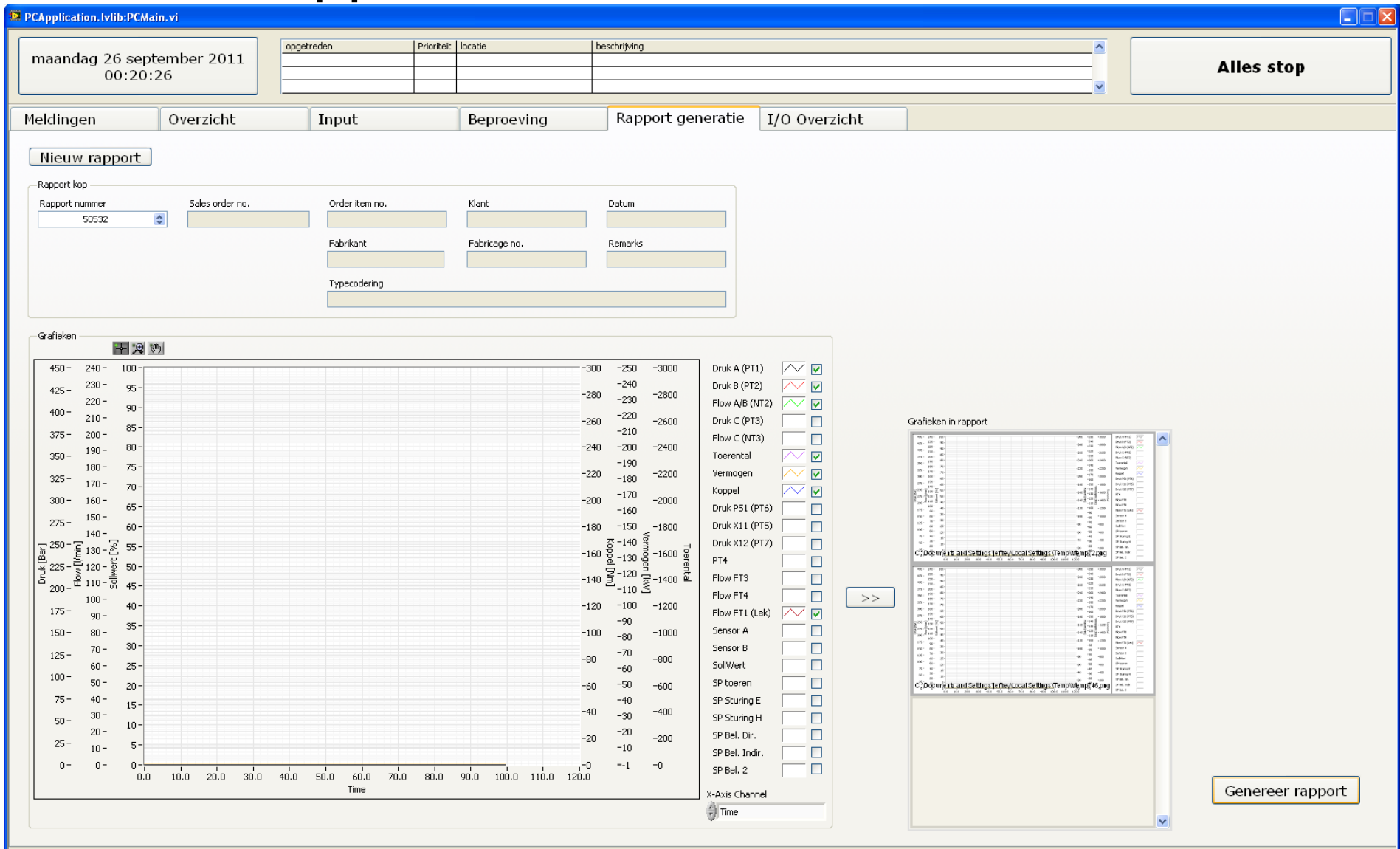
Windows app - User interface



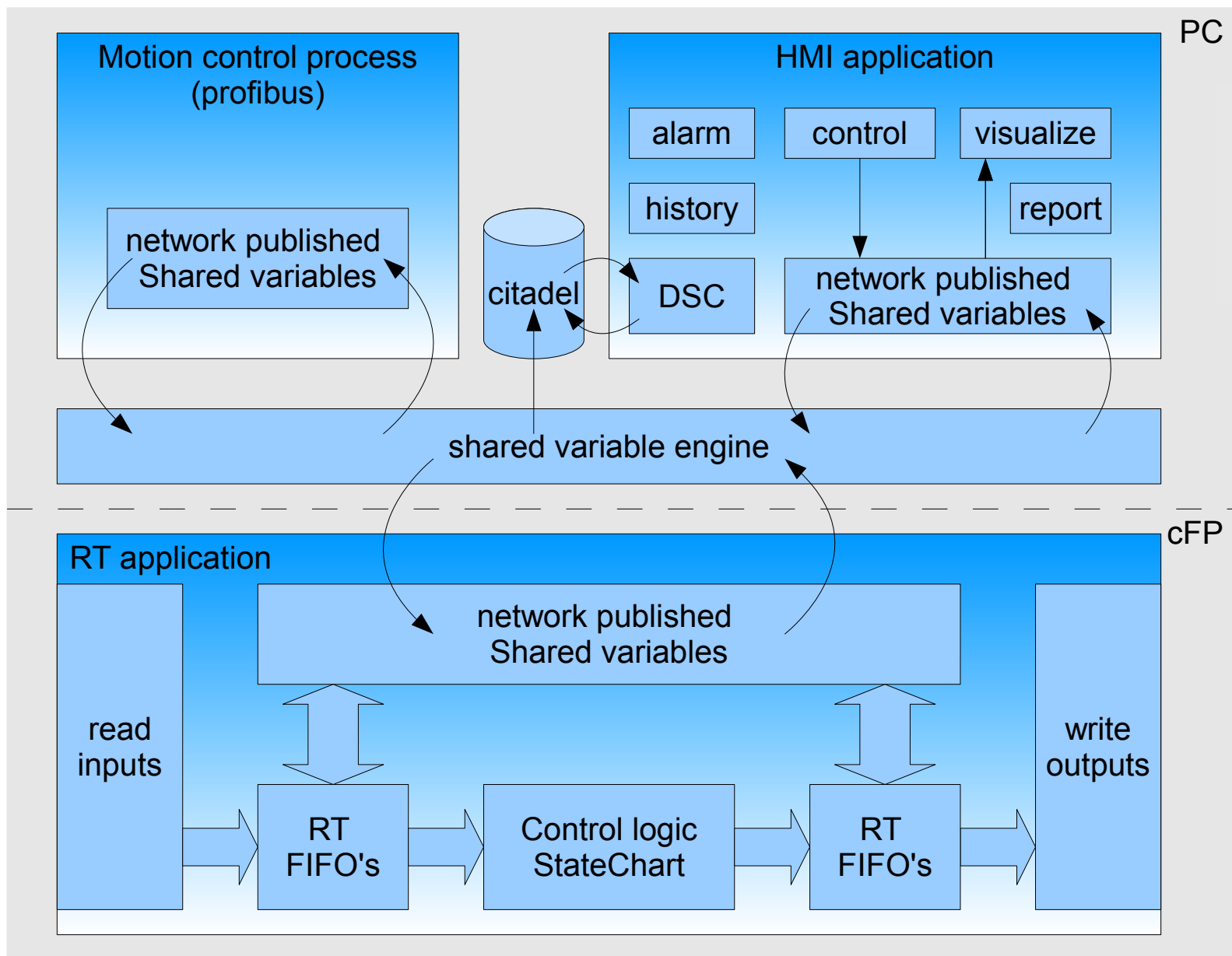
Windows app - User interface



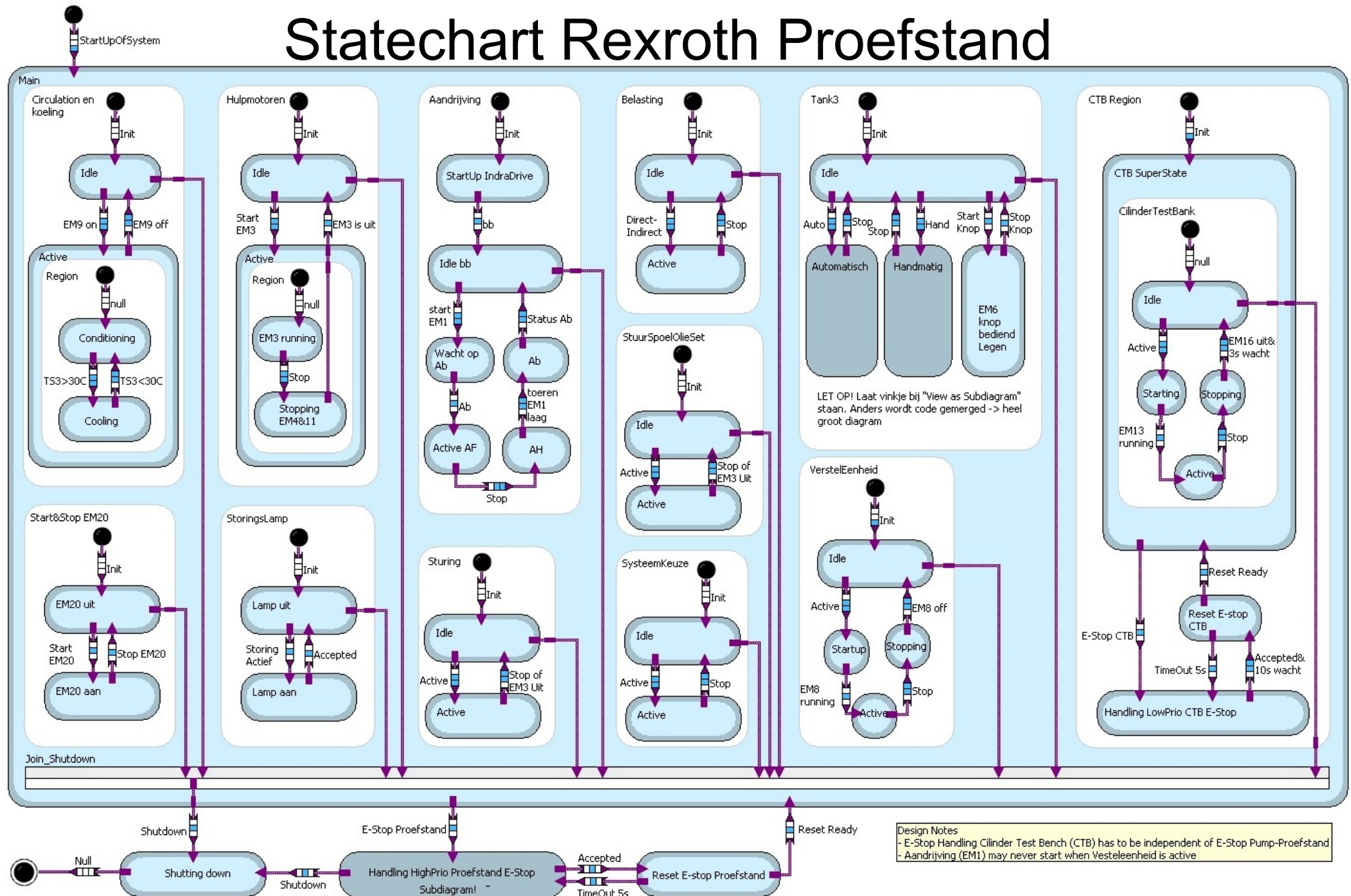
Windows app - User interface



Software overview



Statechart Rexroth Proefstand



Statecharts

- Available as LabVIEW Addon module
- Adds hierarchy and concurrency to statemachine
- Design applications at a higher level
- Generates LabVIEW code
- Runs on RT controllers, FPGA and embedded targets

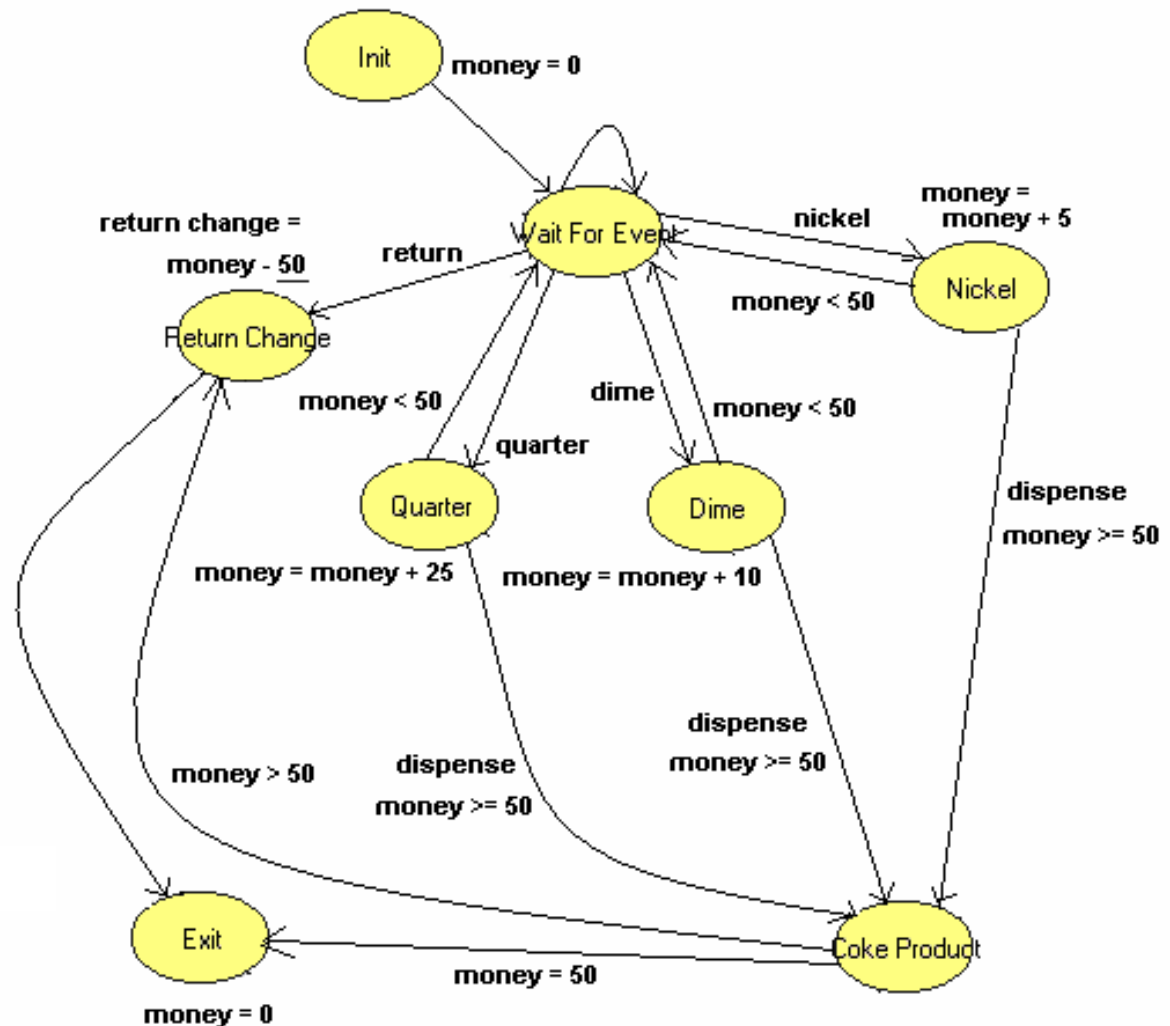
Vending machine state machine



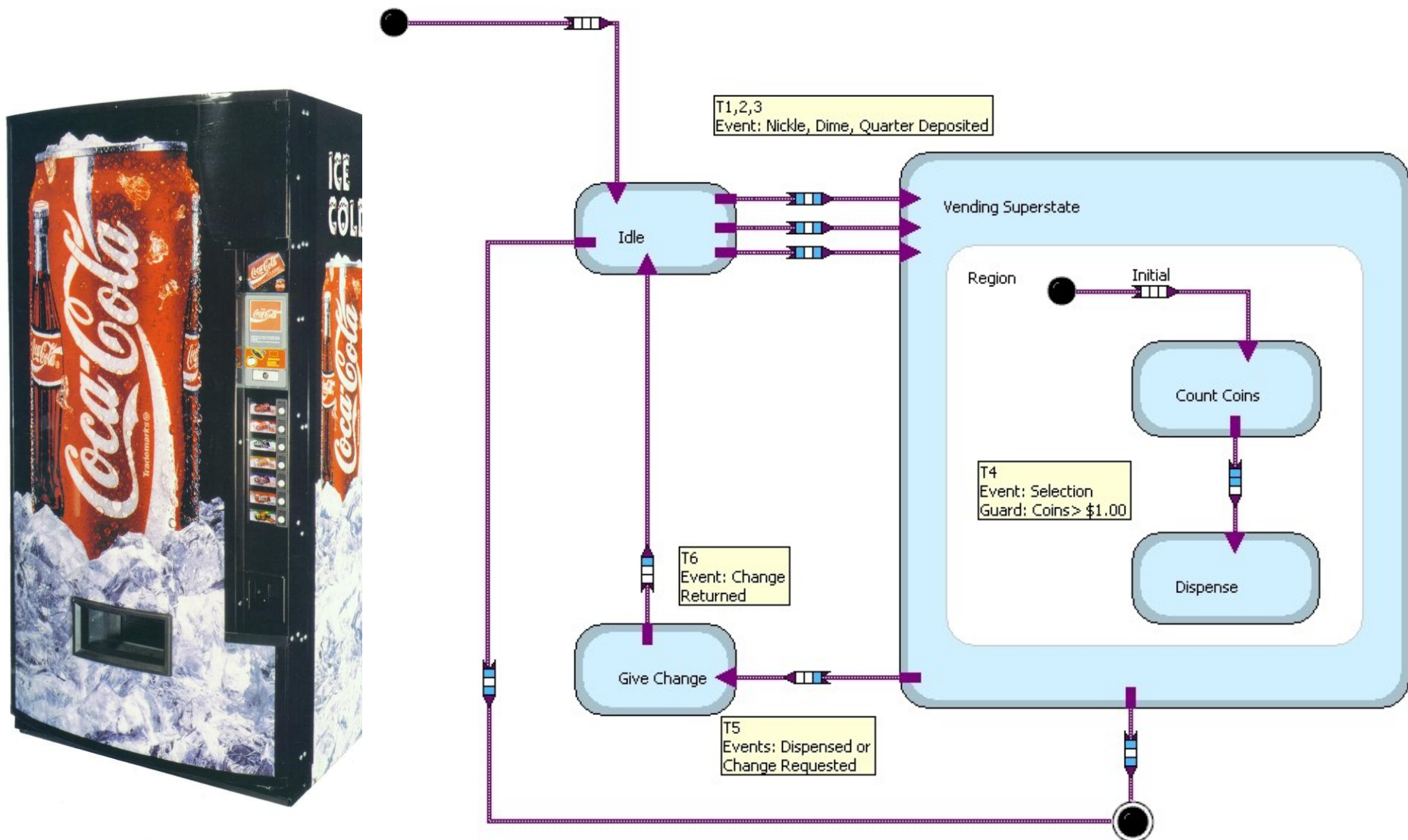
States

- 1.) INIT
 - initialize our Coke Machine
- 2.) WAIT FOR EVENT
 - where the machine waits for coins
- 3.) RETURN CHANGE
 - where the machine returns change
- 4.) COKE PRODUCT
 - machine received 50 or more cents → dispense beverage
- 5.) QUARTER
 - when the customer enters a quarter
- 6.) DIME
 - when the customer enters a dime
- 7.) NICKLE
 - when the customer enters a nickel
- 8.) EXIT
 - after the change is returned and/or beverage dispensed, the machine will power down (application will terminate)

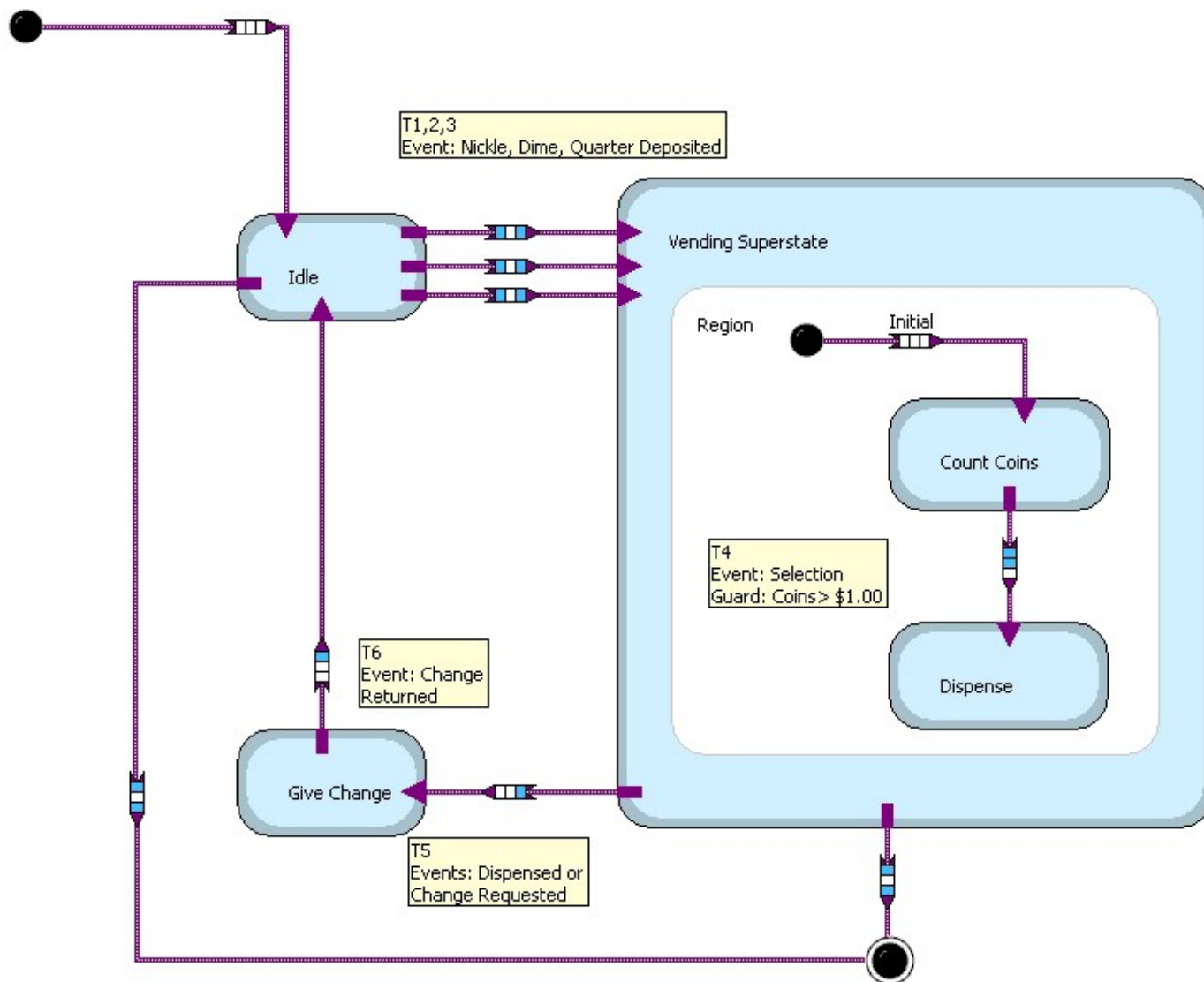
Vending machine state machine



Vending machine statechart



The components of a statechart



components

● Initial pseudostate

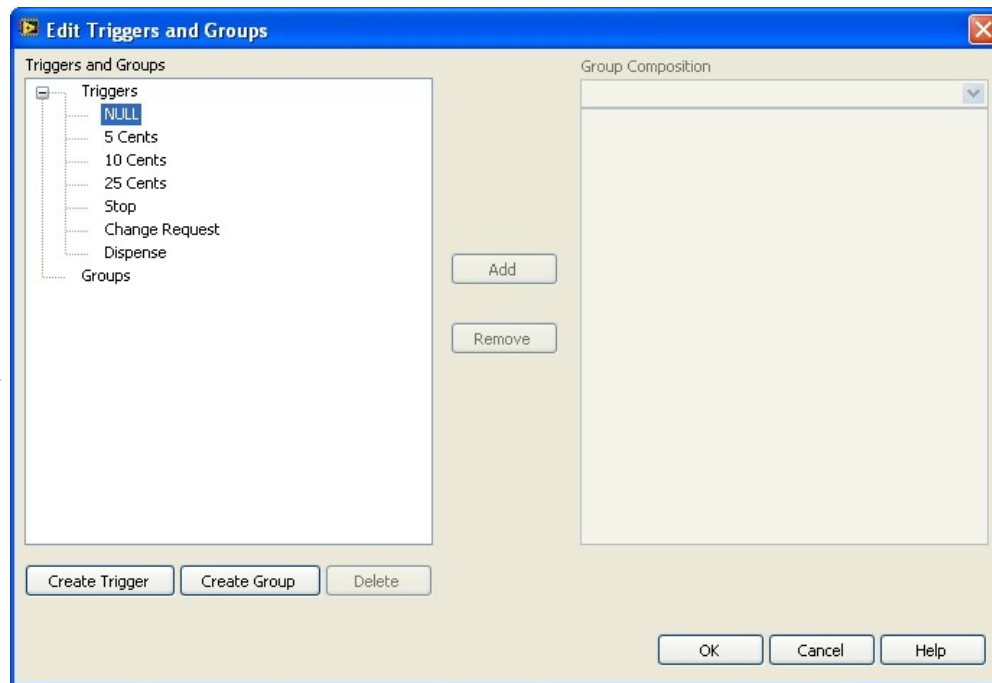
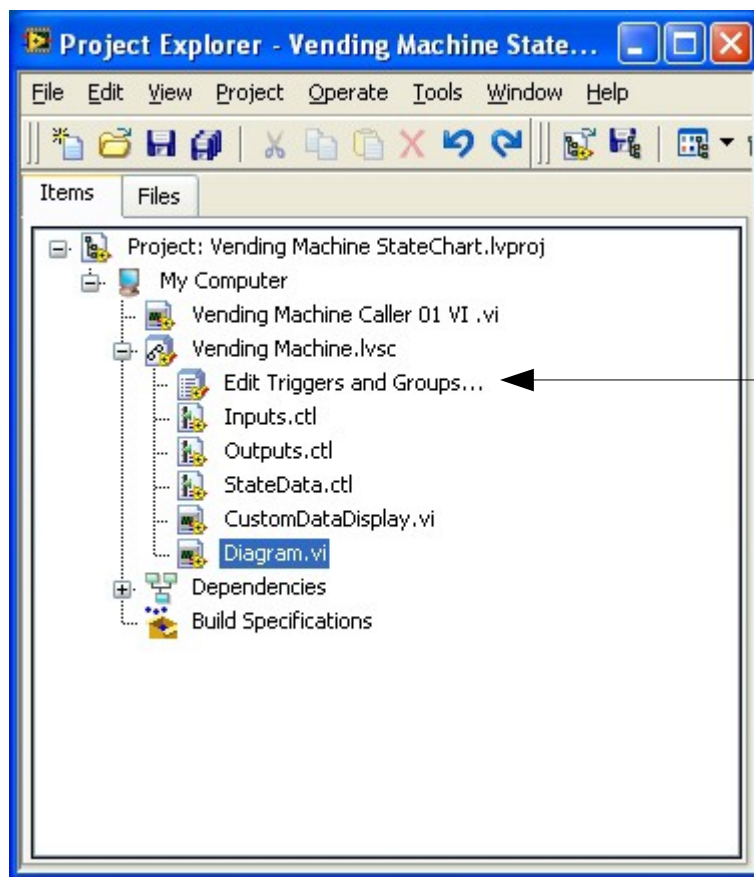
➡ Transition

State

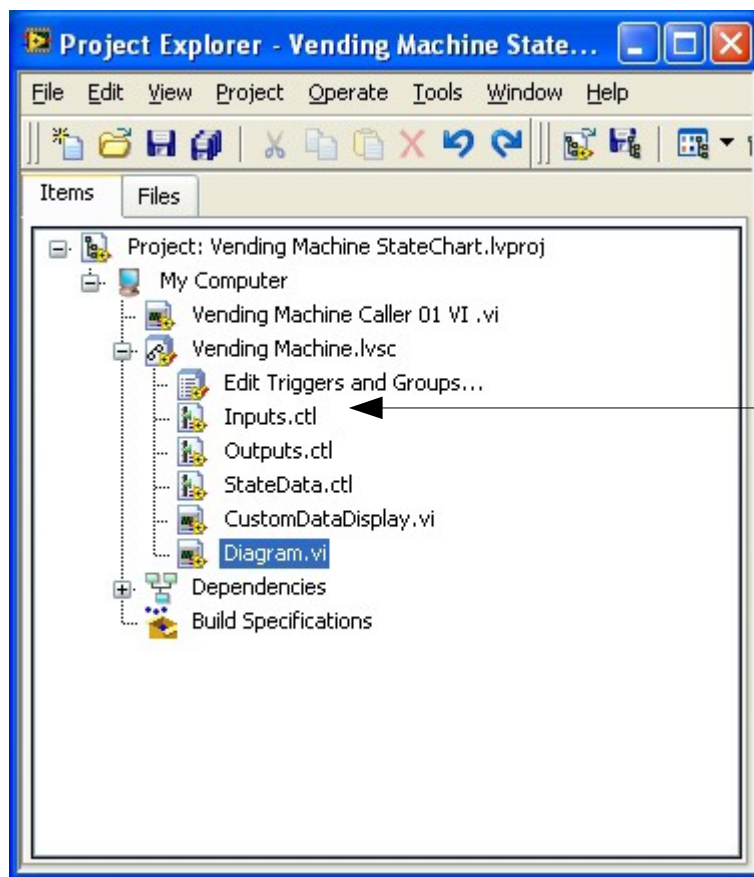
Region

● Terminal pseudostate

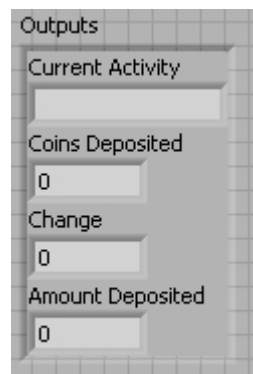
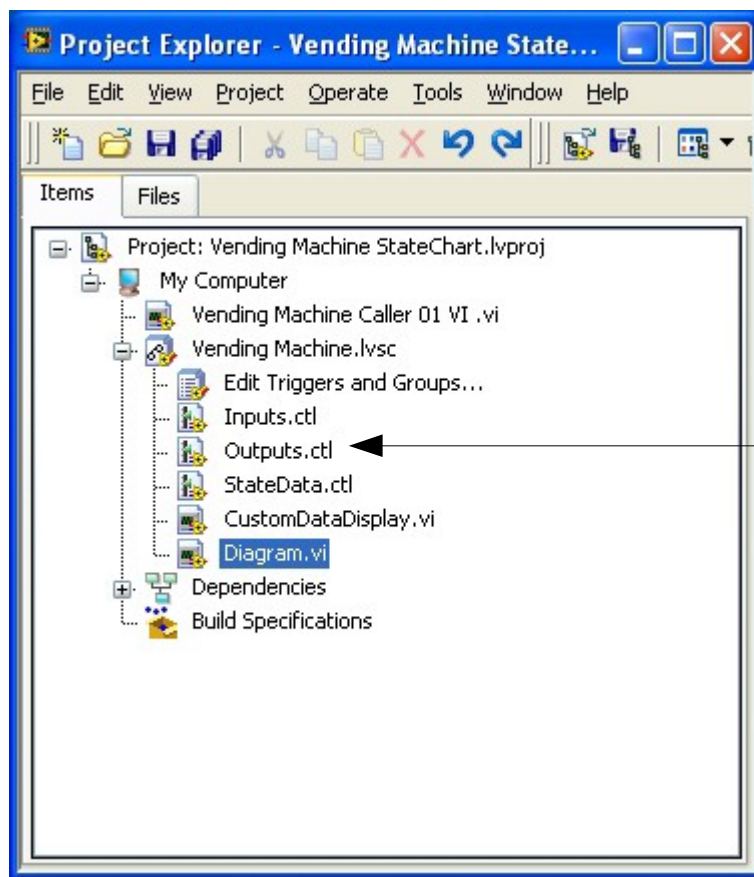
How this looks in the development environment



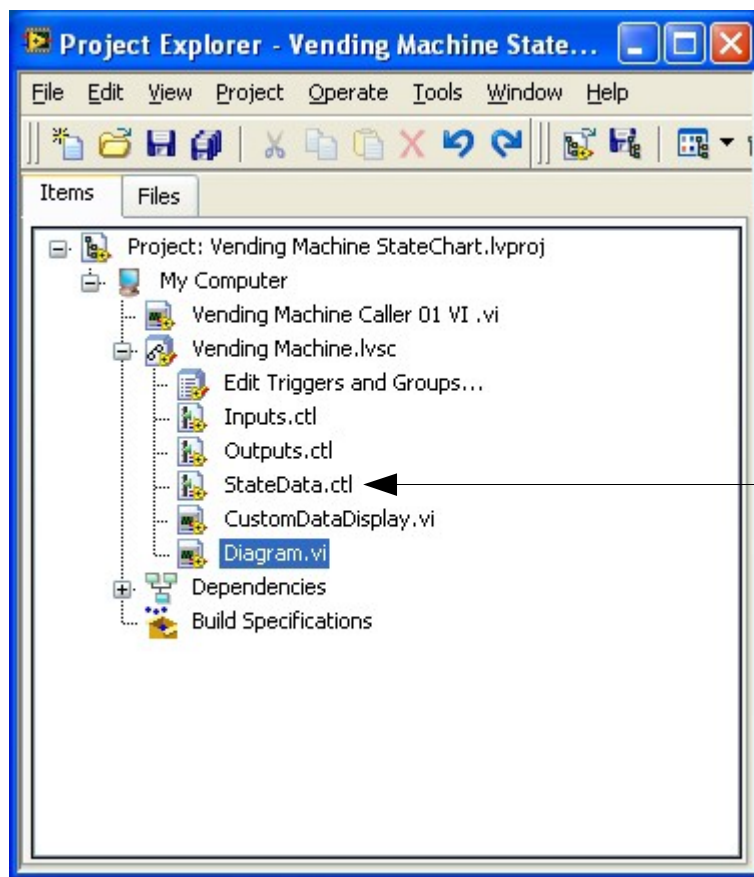
How this looks in the development environment



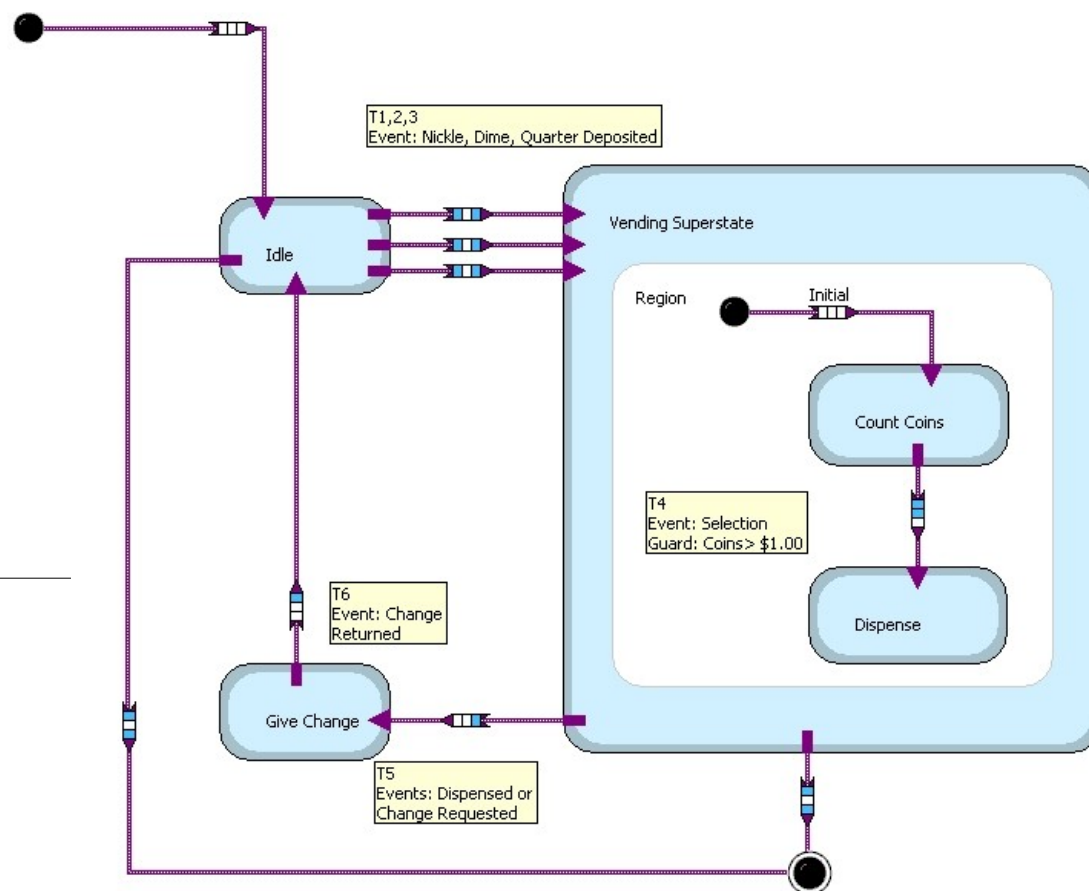
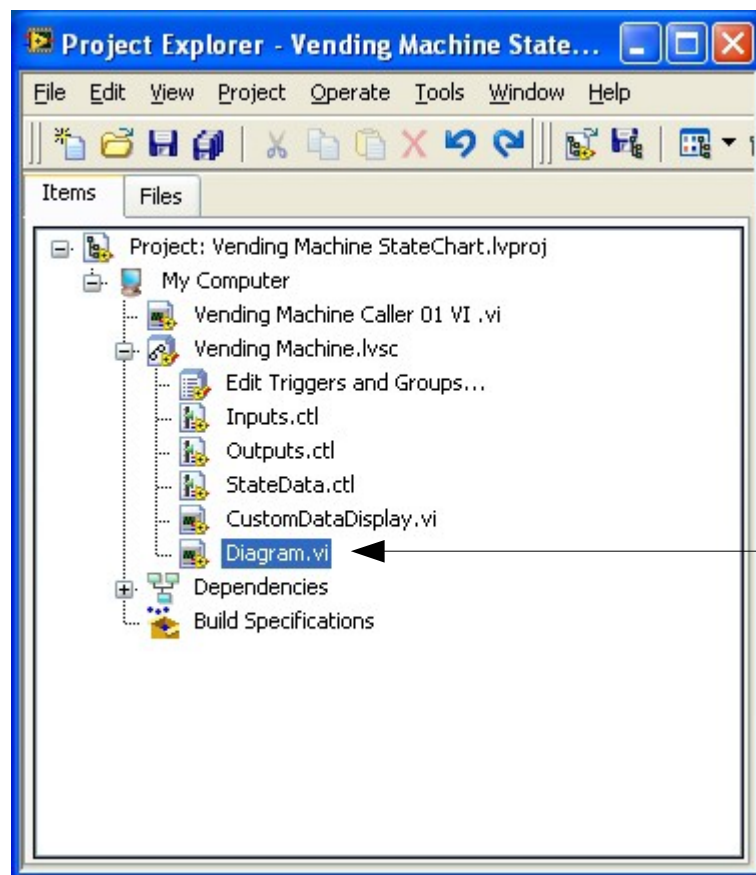
How this looks in the development environment



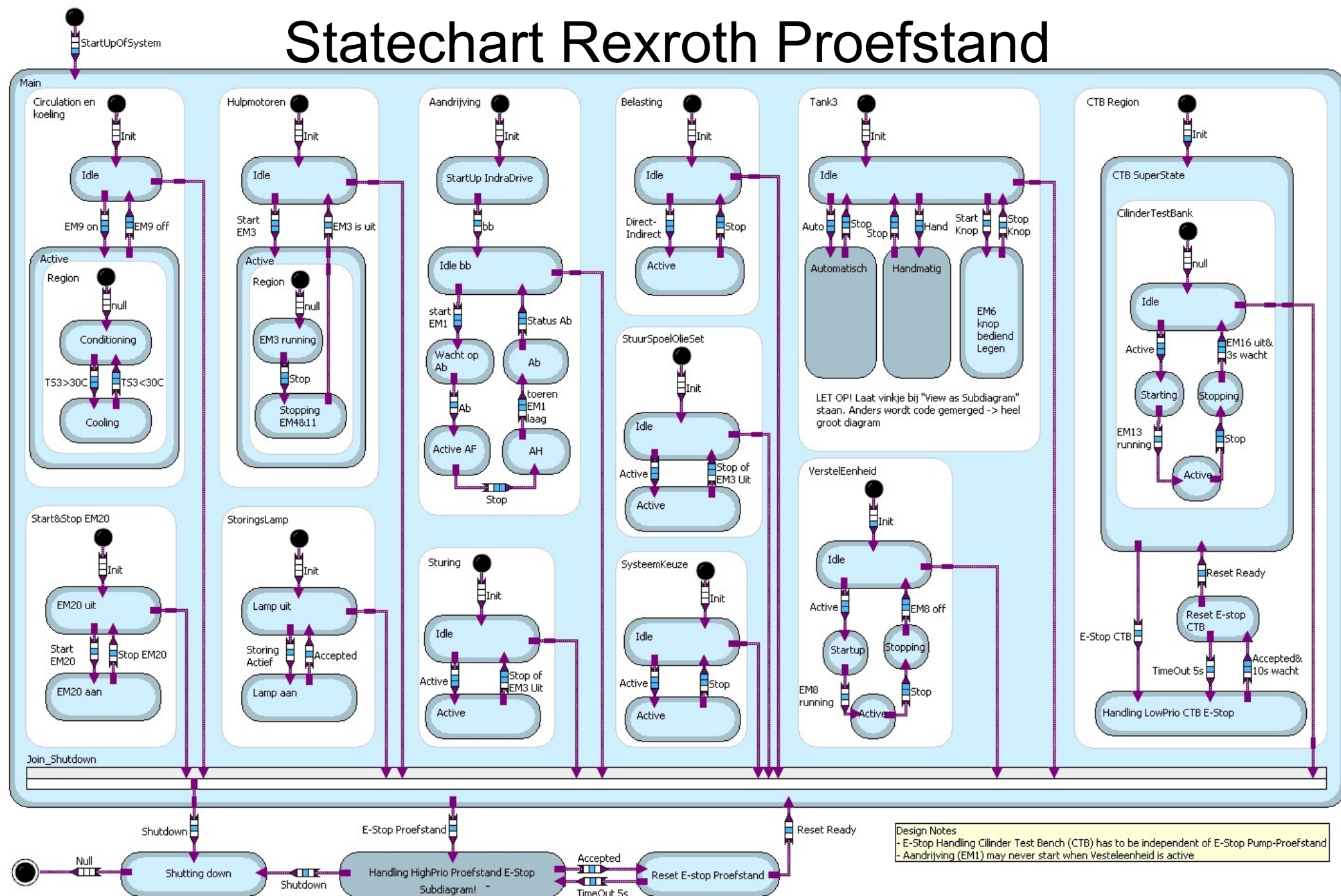
How this looks in the development environment



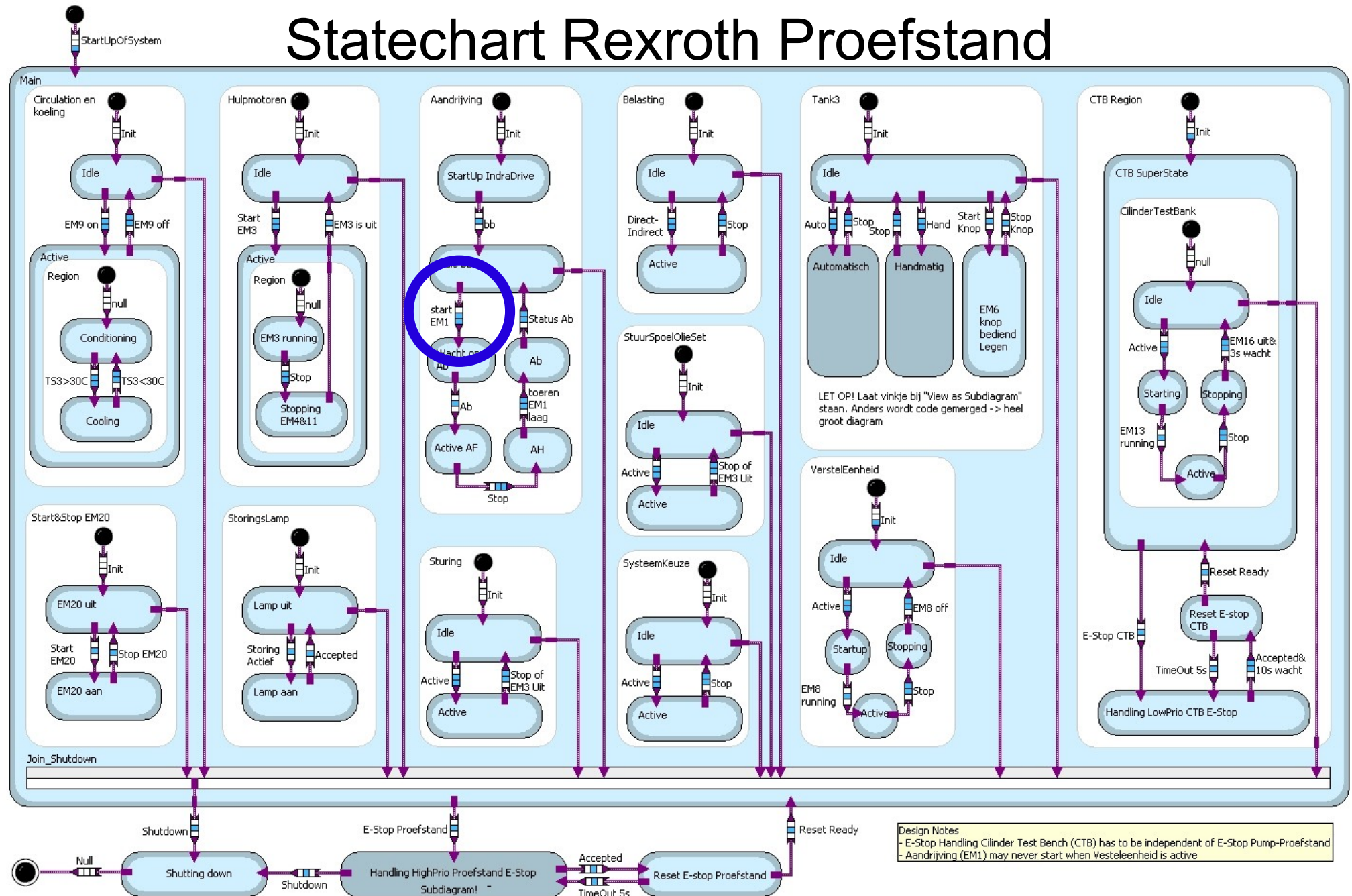
How this looks in the development environment



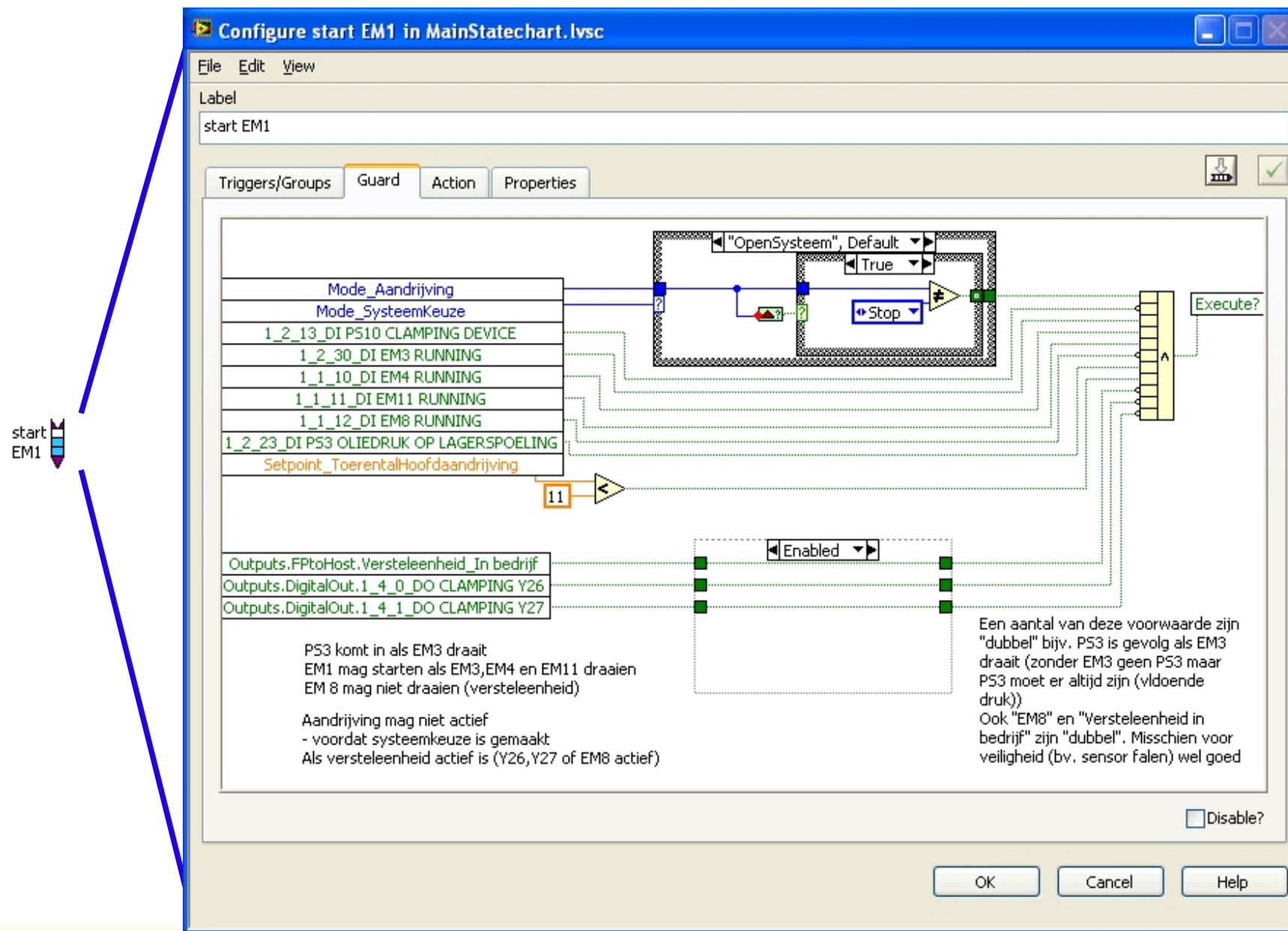
Statechart Rexroth Proefstand



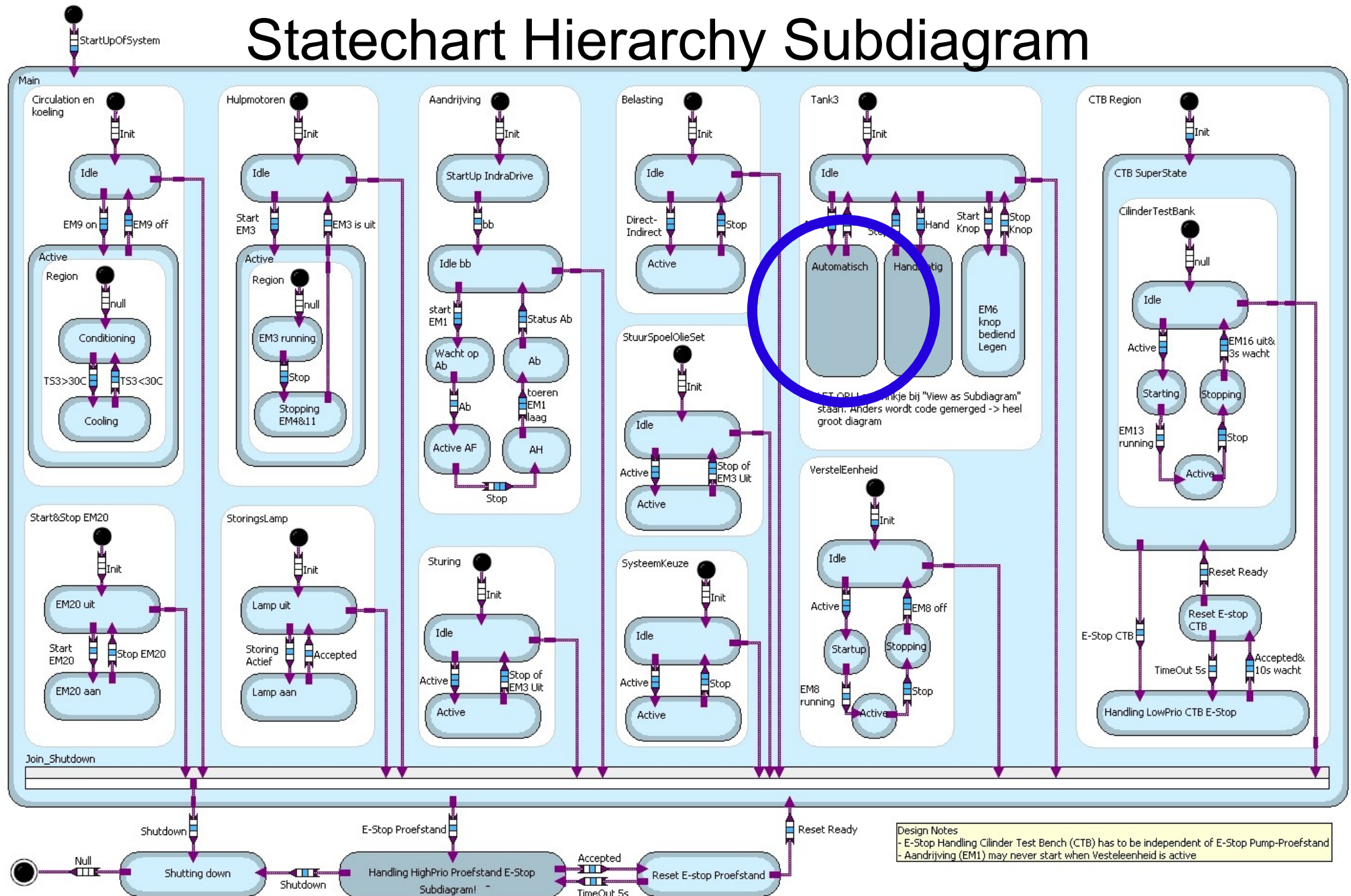
Statechart Rexroth Proefstand



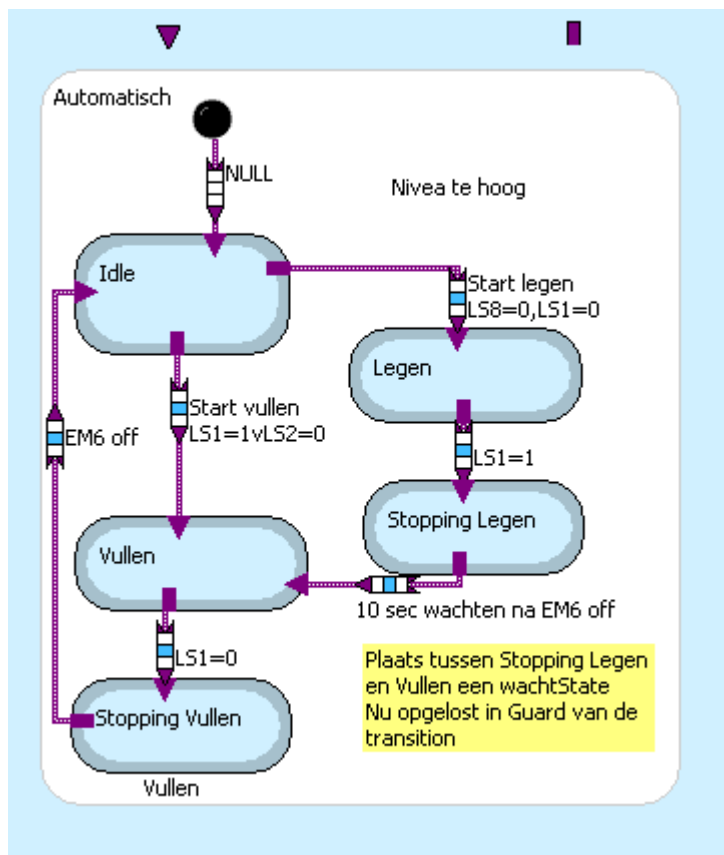
Statechart Proefstand Start EM1 transition



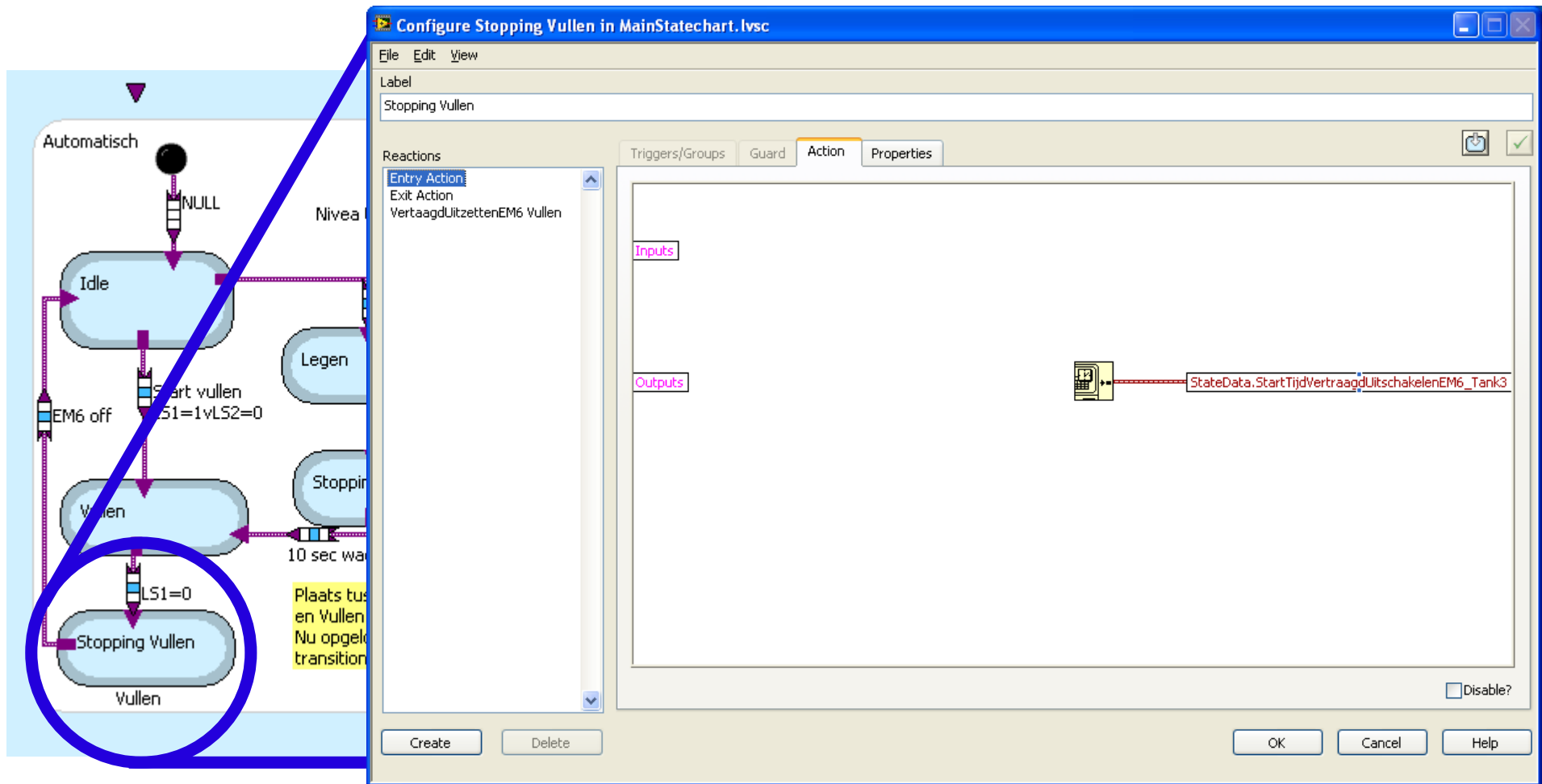
Statechart Hierarchy Subdiagram



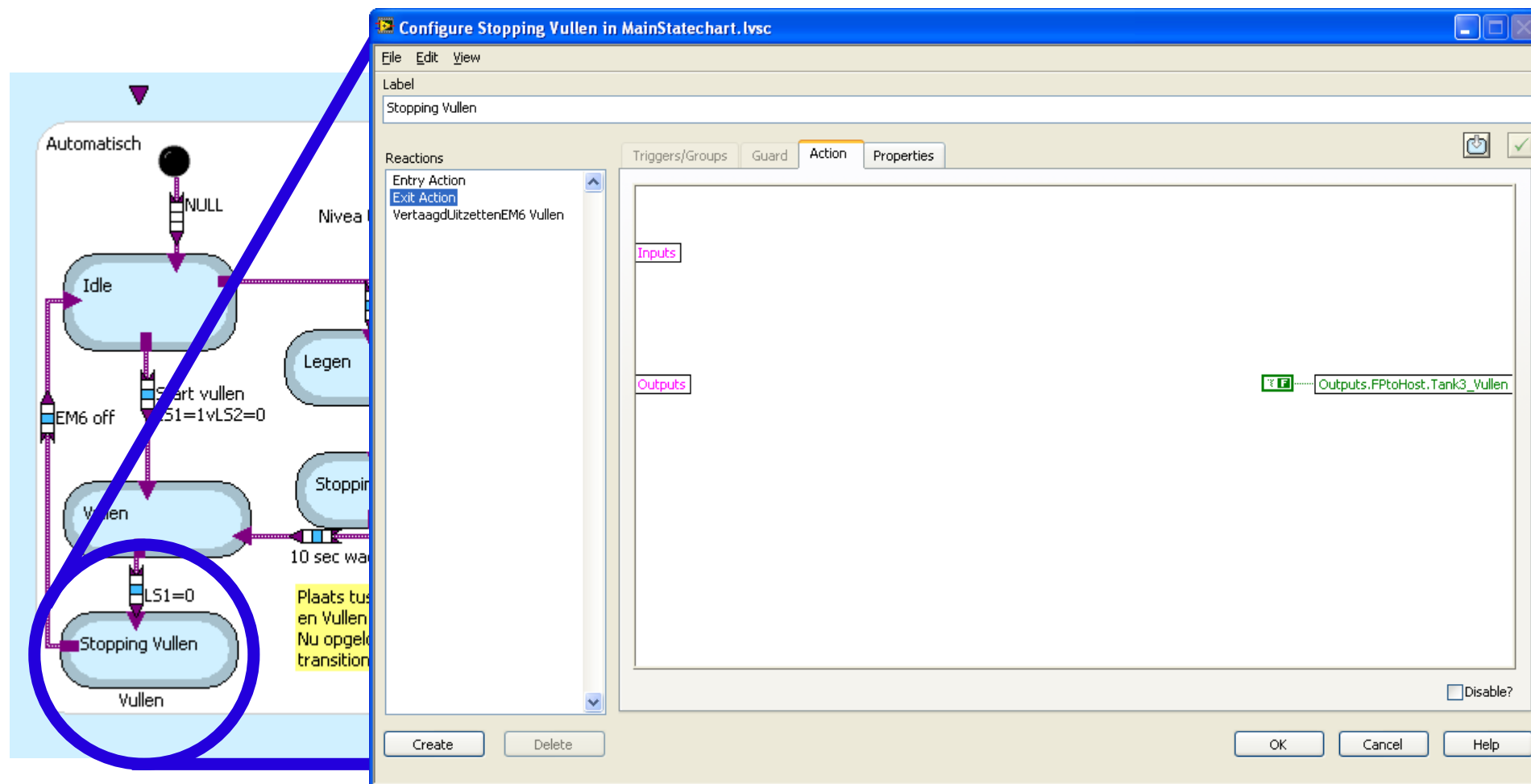
Statechart Subdiagram Automatisch vullen



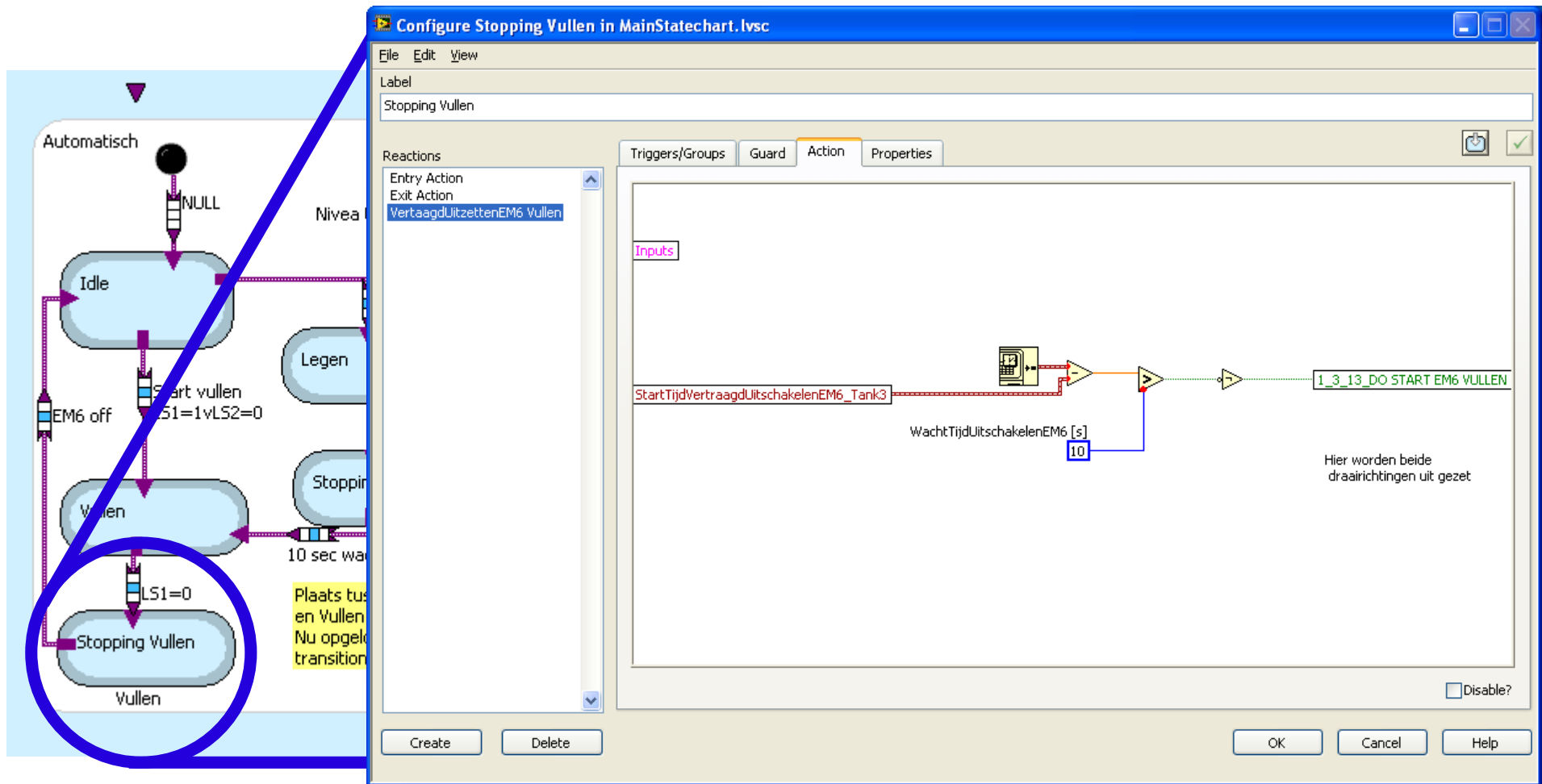
Statechart Entry Action Stopping vullen



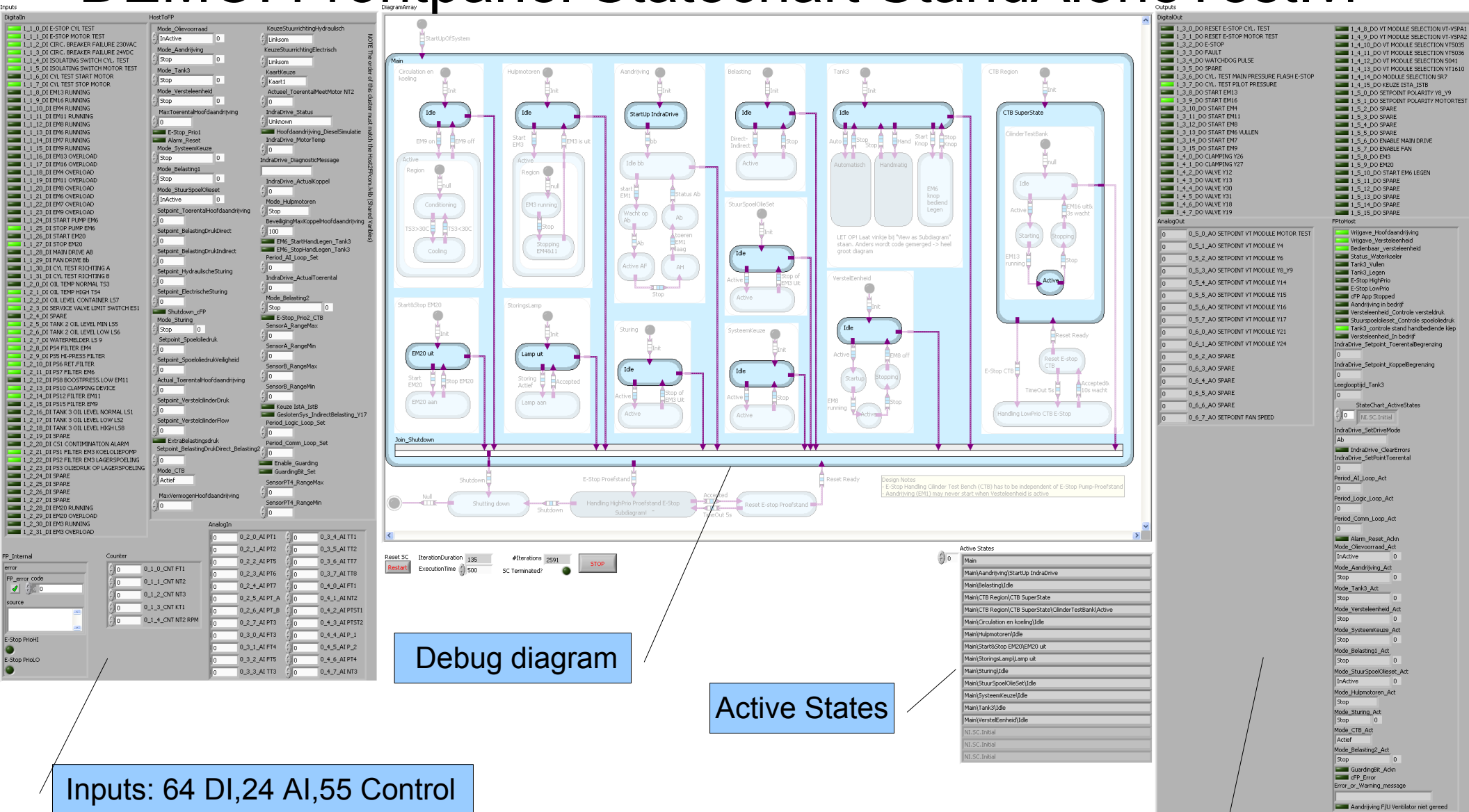
Statechart Exit Action Stopping vullen



Statechart Static Reaction Stopping vullen



DEMO: Frontpanel Statechart StandAloneTest.vi



Benefits experienced

- Changes in system behavior requirements easier
- Offline debugging and simulating of system
- Implementation together with customer / user
- Statechart diagram is readable for other engineers
- Quick overview state of system when online debugging
- Self documenting

Resources

LVUG: LabVIEW State Machines & Statechart Module

<http://zone.ni.com/wv/app/doc/p/id/wv-417>

LVUG: Programming Guidelines and Techniques for the Statechart Module

<http://zone.ni.com/wv/app/doc/p/id/wv-449>

Frequently Asked Questions for the LabVIEW Statechart Module

<http://digital.ni.com/public.nsf/allkb/06B32542713158ED862573A700830B28>

Download the presentation: www.vi-tech.nl

Stay in touch



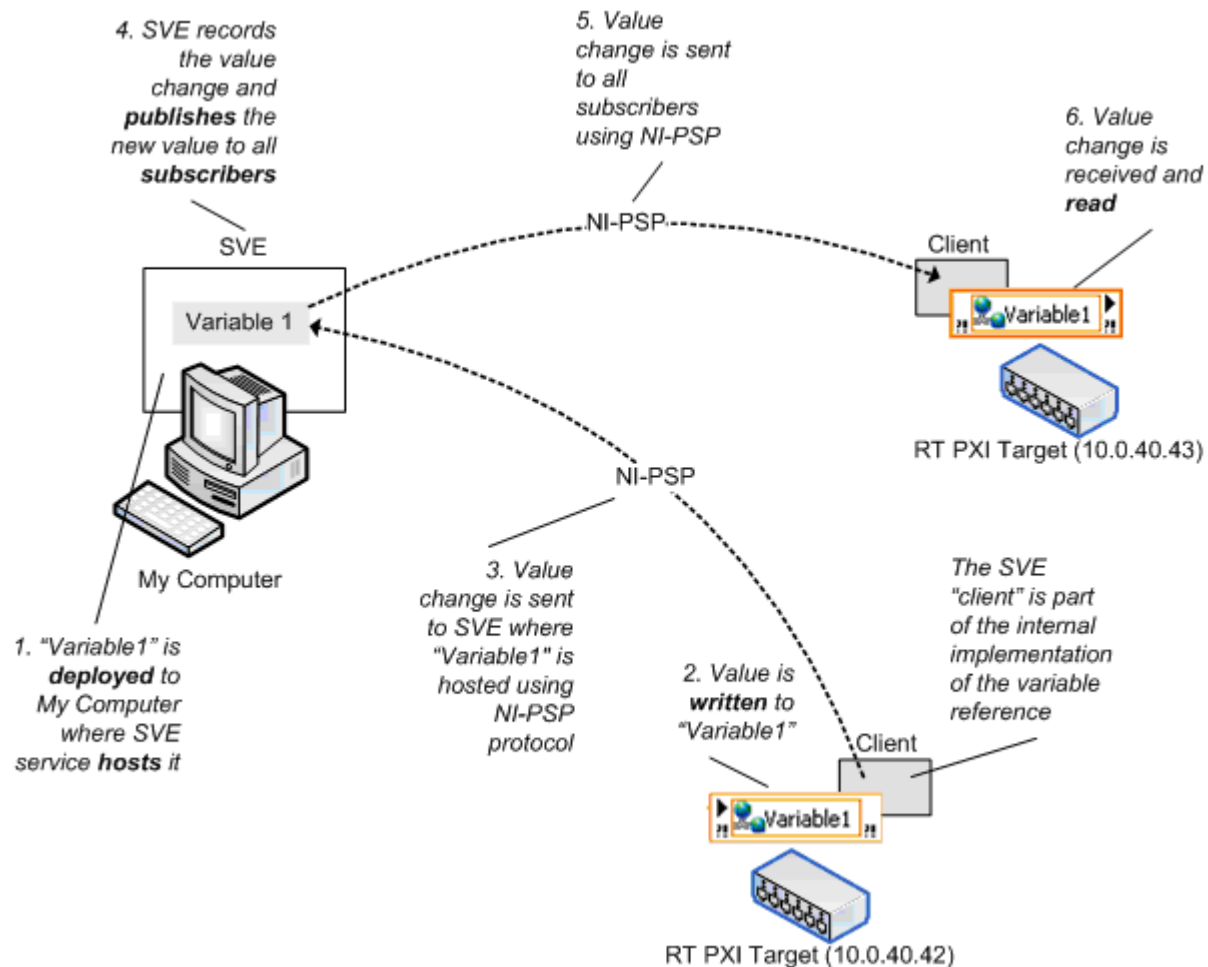
<http://nl.linkedin.com/in/vitech>



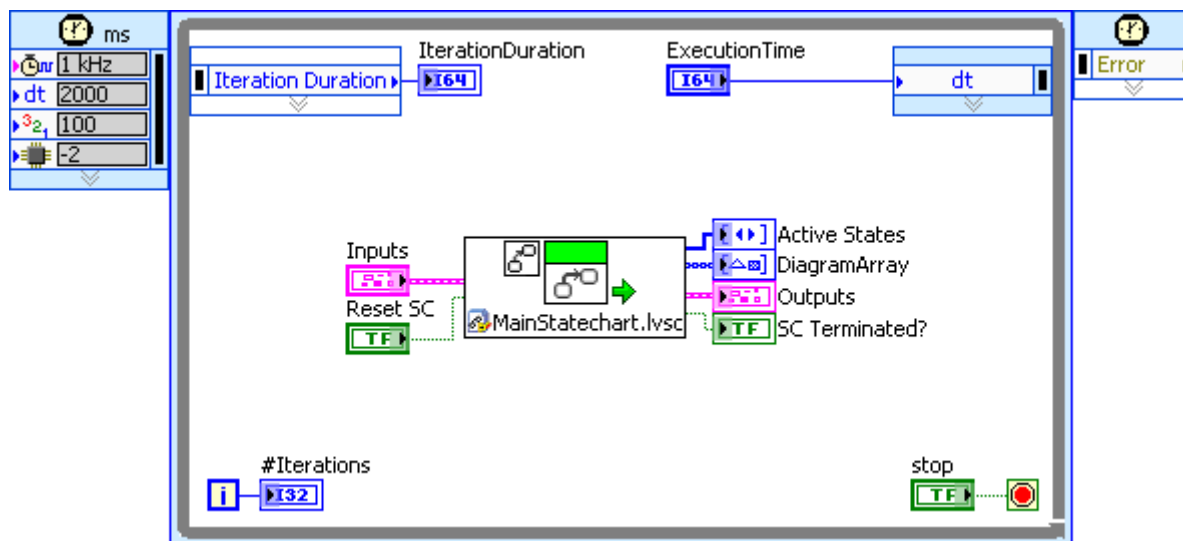
JeffreyHabets

Thanks!

Shared Variable Engine



Example synchronous statechart



Example asynchronous statechart

