DE-4000 SCRIPTING REFERENCE MANUAL

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DE-4000 SCRIPTING REFERENCE MANUAL

There is a delicate balance between providing a system that has capabilities that can be configured through a fixed set of options, and one that can be extended and expanded with custom programming. In designing the DE-4000 control system, the choice was made to provide a system where most applications can be met with simple configuration, but advanced functionality can be provided through custom programming using the “Lua” language.

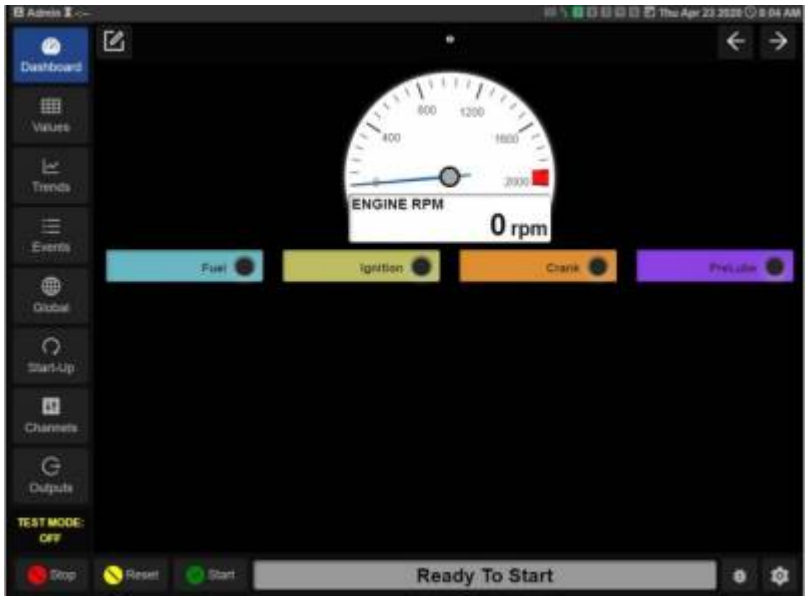
Lua is often referred to as a scripting language. Scripting languages differ from compiled languages as they eliminate extra step of compiling the written program into machine code.

Lua comes with a background of being robust, fast, and geared towards embedded applications, with a proven track record in the gaming industry. For the DE-4000 system it is small and fits in the memory we have available, holds a lot of power, and keeps it simple for writing in the language. All information regarding the Lua scripting language is located at https://Lua.org Using the Lua engine as an embedded tool allows for taking advantage of a full architecture and standard at your fingertips. Within the language there are all of the normal attributes to programming such as functions, variables, statements, expressions etc. All of this reference material can be found at https://lua.org/manual/5.3/ For getting started and using a guided reference, there are several editions of “Programming in Lua” available. Most recent editions are a paid for product that come in paper back or ebook form. While testing out Lua and becoming familiar, a free first edition is available and covers a lot of learning needs to get comfortable with the language. It can be located at https://www.lua.org/pil/contents.html. A major advantage to using Lua is its inherent ability to allow custom functions. While all normal functions and calls are published, there is the ability to add new functions in the DE-4000 firmware. Once new functions are defined and have calls to their internal properties, they then can be published for the user. This includes functions such as our flexible Modbus table and talking with various terminal boards linked in the system. Below is the start to the list of Altronic based functions. As functionality and features come to life through new ideas, this document will continually get updated with the latest scripts that we make available.

GETTING STARTED WITH DE-4000 SCRIPTS Basic Scripting on DE-4000

1. Begin on Dashboard on DE-4000 system environment

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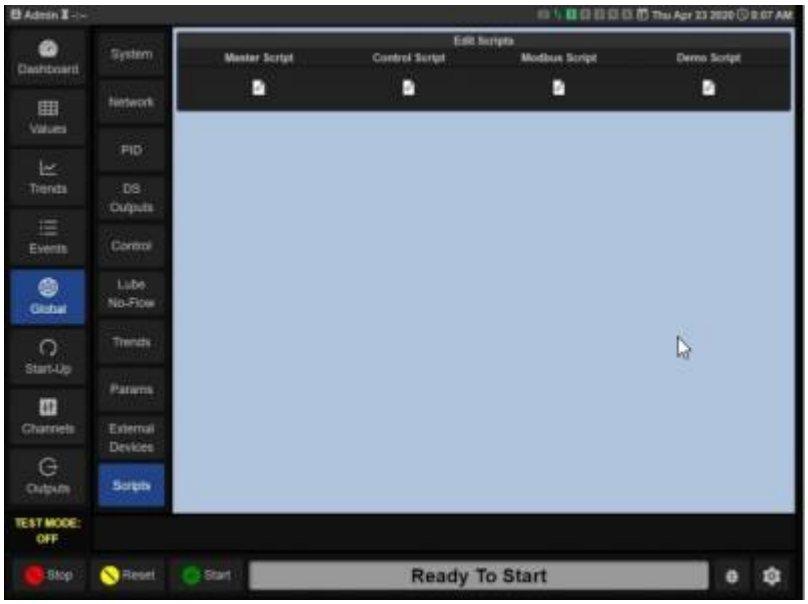


2. Choose “Global” from menu on left side of screen



3. In the Sub-Menu on the Left side select “Scripts”

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4. Select one of the page icons under one of the 4 script options to open editor

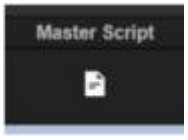


5. Scripting can be entered into the editor

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Scripting Windows and examples

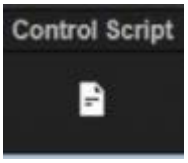
Master Script 

The Master Script section is the Primary scripting environment. Primary scripting functions can be written in this section.

Example:

```
local suction = get_channel_val(1,1)
local discharge1 = get_channel_val(1,3)
diff = discharge1 - suction
set_sVirt(“Difference”, diff)
```

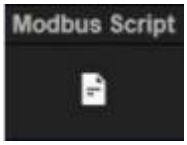
The first line gets the channel value from Terminal board 1 Input 1 and stores it in local variable named suction. The second line gets the channel value from Terminal board 1 Input 3 and stores it in local variable named discharge1. The third line takes the discharge1 pressure and subtracts the suction pressure and stores it in the global variable named diff (NOTE: Any value that you want to access from another scripting section must be stored in a global variable. This is used most in calling values into Modbus registers as explained below). The fourth line copies the value from diff and stores it into the Virtual status channel named “Difference” This channel can be displayed on the Dashboard.

Control Script 

The Control Script section is used to override the default control strategy found on the Global/Control page. A copy of the default control script (found in attached appendix) can be copied into this section and then modified to change the control functionality as well as add additional control loops beyond the default 2.

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Modbus Script 

The Modbus Script section is used to move data into and out of Modbus registers




```
defaultModbus()
set_modbus(300,diff)
```

The first line pulls in the factory set Modbus mapping The second line moves the value from the global variable named diff into the 40300 Modbus Register

5.1 DE4000 Lua Script API

CUSTOM FUNCTIONS FOR SCRIPTING

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create_param("index",default,"catergory","description")

- creates a user configurable parameter
- parameter is stored as `index`,
- default value(If not changed by user) is `default`
- parameters will be grouped on the Global/Params page by `category`
- `description` is text to describe the parameter to the user

Example:

```
create_param("NumEngCyl",8,"Engine Params","Num. of Engine Cylinders")
```

---

get_channel_val(terminal,channel)

- returns current value of analog input `channel` on terminal module `terminal`
- return value type is numeric

Example:

```
local sp = get_channel_val(1,5)
```

> reads value of Suction Pressure from Terminal Module #1 , Input #5

---

get_gbl("index",default)

- returns global config setting stored under `index` or returns `default` if not defined

> **note:** get_gbl is used to retrieve global CONFIGURATION settings that are typically set when the system is configured and do not change as the system is running. If you want to set and retrieve global STATUS variables use the get_sGbl() and set_sGbl() functions >If you want to create and read virtual channels use the set_sVirt() and get_sVirt() functions.

Example:

```
local nt = get_gbl("NumTerm",1)
```

> gets the number of terminal boards installed in the system

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get_param("index")

- return either the default value or the user configured value of the parameter `index`

Example:

```
get_param("NumEngCyl")
```

>gets the configured parameter for number of engine cylinders

---

get_rpm(channel)

- reads the RPM input `channel` in units of revolutions per minute

> **note:** valid channel numbers are 1 - 10(2 channels per board, up to 5 terminal boards)

Each Terminal Module has 2 RPM inputs (RPM1 and RPM2)

- Terminal Module **#1** RPM channels are **1,2**
- Terminal Module **#2** RPM channels are **3,4**
- Terminal Module **#3** RPM channels are **5,6**
- Terminal Module **#4** RPM channels are **7,8**
- Terminal Module **#5** RPM channels are **9,10**

Example:

```
local engineRPM = get_rpm(1)
local turboRPM = get_rpm(6)
```

> Read RPM1 channel from terminal module #1 and read RPM2 channel from Terminal module #3

---

get_sGbl("index", default)

- If `index` is defined in the global status table then it returns the value associated with `index`
- If `index` is not defined and optional `default` is provided then returns `default`

>**note:** It is recommended to always provide a default value when using this function

Example:

```
local cp = get_sGbl("calculatedPressure",0)
```

> get the previously stored value "calculatedPressure", Returns `0` if not found.

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get_state()

- returns the current engine state(possible values currently 0 - 10)

Example:

```
local engineState = get_state()
if engineState > 7 then
    set_timer("WarmupTimer",1000)
end
```

---

get_sVirt("index")

- returns the value of virtual channel `index` or returns `default` if the virtual channel does not exist.

Example:

```
local tl = get_sGbl("timeLimit")
local et = get_sVirt("ElapsedTime",0)
if et > tl then
    set_sGbl("timeExceeded",true)
else
    set_sGbl("timeExceeded",false)
end
```

>Gets the value of virtual channel ElapsedTime and set value of status global "timeExceeded" if ElapsedTime is greater than status global "timeLimit"

---

get_time()

- returns the UNIX "epoch" time (Defined as the number of seconds elapsed since Jan 1, 1970)

Example:

```
local startTime = get_sGbl("startTime",0)
if startTime == 0 then
    local currentTime = get_time()
    startTime = currentTime
    set_sGbl("startTime",currentTime)
end
local et = get_time() - startTime
set_sVirt("ElapsedTime",et)
```

>Stores current time if first time through, otherwise calculate elapsed time

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get_timer("index")

- returns 1 or 2 values
- First return value(Boolean) is **true** if timer is active(counting down) or **false** if timer is expired or has not been set yet
- Second return value is the number of seconds remaining or **-1** if timer is not active or has not been set yet

Example:

```
if not get_timer("myTimer") then
    set_sGbl("timedOut",true)
else
    set_sGbl("timedOut",false)
end
```

> if timer is expired, then set global status "timedOut" to **true**

```
local active,remaining = get_timer("myTimer")
if not active then
    set_sVirt("timeRemaining","Expired")
else
    set_sVirt("timeRemaining",remaining)
end
```

---

getStateLabel(state)

- return the label for the engine state corresponding to the parameter `state`

Example:

```
local stateLabel = getStateLabel(get_state())
local active, remaining = get_timer("myTimer")
if remaining > 0 then
    stateLabel == StateLabel.." "..remaining
end
set_sVirt("Countdown",stateLabel)
```

---

set_sGbl("index",value)

- store `value` in the global status table under `index`
- value can be a number or string but if storing a boolean use the **tostring()** function

Example:

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```
local mpe = false
local sp = get_channel_val(1,5)
if sp > 15 then
    mpe = true
end
set_sGbl("minPressureExceeded",tostring(mpe))
```

> store boolean value **minPressureExceeded**

---

set_sVirt("index",value)

- sets a virtual status channel with channel name `index`

> **Note:** Once you create a virtual channel, you can add that channel to the dashboard using the channel name `index`

Example:

```
local sp = get_channel_val(1,5) --suction pressure
local dp = get_channel_val(1,6) --discharge pressure
local diffPress = dp - sp
set_sVirt("SuctDischDiff",diffPress)
```

> calculate the differential between suction and discharge pressure and assign to virtual channel

---

set_timer("index",secs)

- activate timer `index` and set countdown time to `secs`

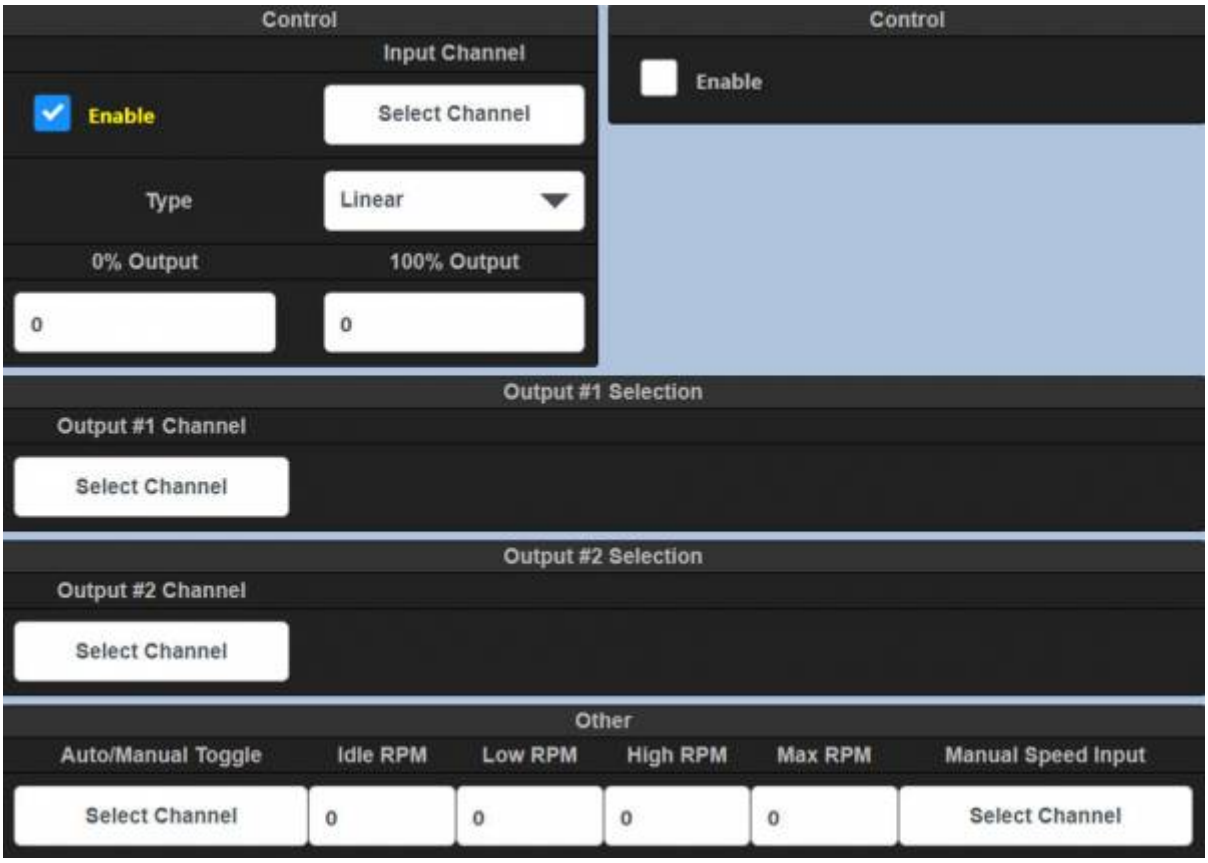
Example:

```
set_timer("myTimer",300)
```

> create timer `myTimer` and start countdown time to 300 seconds

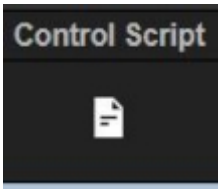
5.2 Master Control Script

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When you enter a control setup under the Global Control page the code that runs is called MasterControl.

If you wish to modify this functionality you can copy this code into the Control Script editor and make your changes to the standard configuration.



mastercontrol.lua

```
local rampRate1 = get_gbl("rampRate1",0.8)
local rampRate2 = get_gbl("rampRate2",0.8)
local dischTerm = tonumber_def(get_gbl("spDischTerm",0),0)
local dischChan = tonumber_def(get_gbl("spDischChan",0),0)
local suctTerm = tonumber_def(get_gbl("spSuctTerm",0),0)
local suctChan = tonumber_def(get_gbl("spSuctChan",0),0)
local suctMin = tonumber_def(get_gbl("suctMin",0),0)
local recycleMin = tonumber_def(get_gbl("recycleMin",0),0)
local recycleMax = tonumber_def(get_gbl("recycleMax",0),0)
local suctSp = tonumber_def(get_gbl("suctSp",0),0)
local dischMax = tonumber_def(get_gbl("dischMax",0),0)
local dischSp = tonumber_def(get_gbl("dischSp",0),0)
local outputTerm = tonumber_def(get_gbl("outputTerm",0),0)
local outputChan = tonumber_def(get_gbl("outputChan",0),0)
local recycleTerm = tonumber_def(get_gbl("outputTerm2",0),0)
local recycleChan = tonumber_def(get_gbl("outputChan2",0),0)
```


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```
17.   local speedRevAct = tonumber_def(get_gbl("speedRevAct",0),0)
18.   local recycleRevAct = tonumber_def(get_gbl("recycleRevAct",0),0)
19.   local outputLow = tonumber_def(get_gbl("outputLow",0),0)
20.   local outputLow2 = tonumber_def(get_gbl("outputLow2",0),0)
21.   local outputHigh = tonumber_def(get_gbl("outputHigh",0),0)
22.   local outputHigh2 = tonumber_def(get_gbl("outputHigh2",0),0)
23.   local spSuctType = get_gbl("spSuctType","linear")
24.   local spDischType = get_gbl("spDischType","linear")
25.   local suctPIDPFactor =
    tonumber_def(get_gbl("suctPIDPFactor",0),0)
26.   local suctPIDIFactor =
    tonumber_def(get_gbl("suctPIDIFactor",0),0)
27.   local suctPIDDFactor =
    tonumber_def(get_gbl("suctPIDDFactor",0),0)
28.   local dischPIDPFactor =
    tonumber_def(get_gbl("dischPIDPFactor",0),0)
29.   local dischPIDIFactor =
    tonumber_def(get_gbl("dischPIDIFactor",0),0)
30.   local dischPIDDFactor =
    tonumber_def(get_gbl("dischPIDDFactor",0),0)
31.   local recycleCtrl = false
32.   local recycleSuctionRev = false
33.   local recycleDischargeRev = false
34.   if recycleChan > 0 and recycleTerm > 0 then
35.     recycleCtrl = true
36.   end
37.
38.   local dischPct = 100
39.   local suctPct = 100
40.
41.
42.   local dischOutput = 0
43.   local suctOutput = 0
44.   local rSuctOutput = 0
45.   local rDischOutput = 0
46.   local minLoad = 0
47.   local maxLoad = 100
48.   local minRecycle = 0
49.   local maxRecycle = 100
50.   local speedTarget = get_sGbl("speedTarget",0)
51.   local recycleTarget = get_sGbl("recycleTarget",0)
52.
53.   function map_range(rangeLow,rangeHigh,input)
54.     if input <= rangeLow and input <= rangeHigh then
55.       return 0
56.     end
57.     if input >= rangeLow and input >= rangeHigh then
58.       return 100
59.     end
60.     local rangeDiff = math.abs(rangeLow - rangeHigh)
61.     local min = math.min(rangeLow,rangeHigh)
```


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```
    local retval = math.abs(input - min) / rangeDiff * 100
    if retval > 100 then retval = 100 end
    if retval < 0 then retval = 0 end
    return retval
  end

  local suct = false
  local suctVal = 0
  if tonumber_def(get_gbl("spSuctEn",0),0) == 1 then
    if suctTerm > 0 and suctChan > 0 then
      suctVal = get_channel_val(suctTerm,suctChan)
      suct = true
    end
  end


  if suct then
    if spSuctType == "linear" then
      local suctDiff = suctSp - suctMin
      if suctDiff == 0 then suctDiff = 1 end
      if suctVal < suctSp then
        local suctErr = suctSp - suctVal
        suctPct = suctErr / suctDiff
        if suctPct > 1 then suctPct = 1 end
        if suctPct < 0 then suctPct = 0 end
        suctOutput = (1 - suctPct) * 100
      else
        suctOutput = 100
      end
    else
      set_gbl("PIDsuctEnable",1)
      set_gbl("PIDsuctPFactor",suctPIDPFactor)
      set_gbl("PIDsuctIFactor",suctPIDIFactor)
      set_gbl("PIDsuctDFactor",suctPIDDFactor)
      set_gbl("PIDsuctSp",suctSp)
      set_gbl("PIDsuctDeadband",0.2)
      local suctPidOutput = doPid("suct",suctVal)
      suctOutput = suctPidOutput
    end
  else
    suctOutput = 100
  end


  local disch = false
  local dischVal = 0
  if tonumber_def(get_gbl("spDischEn",0),0) == 1 then
    if dischTerm > 0 and dischChan > 0 then
        dischVal = get_channel_val(dischTerm,dischChan)
        disch = true
    end
```


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```
113.   end
114.   if disch then
115.     if spDischType == "linear" then
116.       local dischDiff = dischMax - dischSp
117.       if dischDiff == 0 then dischDiff = 1 end
118.       if dischVal > dischSp then
119.         local dischErr = dischVal - dischSp
120.         dischPct = dischErr / dischDiff
121.         if dischPct > 1 then dischPct = 1 end
122.         if dischPct < 0 then dischPct = 0 end
123.         dischOutput = (1 - dischPct) * 100
124.       else
125.         dischOutput = 100
126.       end
127.     else
128.       set_gbl("PIDdischEnable",1)
129.       set_gbl("PIDdischPFactor",dischPIDPFactor)
130.       set_gbl("PIDdischIFactor",dischPIDIFactor)
131.       set_gbl("PIDdischDFactor",dischPIDDFactor)
132.       set_gbl("PIDdischSp",dischSp)
133.       set_gbl("PIDdischRevAct",1)
134.       set_gbl("PIDdischDeadband",0.2)
135.       local dischPidOutput = doPid("disch",dischVal)
136.       dischOutput = dischPidOutput
137.     end
138.   else
139.     dischOutput = 100
140.   end
141.
142.
143.   local minOutput = 100
144.   local winning = 0
145.   if suctOutput < minOutput then
146.     minOutput = suctOutput
147.     winning = 1
148.   end
149.   if dischOutput < minOutput then
150.     minOutput = dischOutput
151.     winning = 2
152.   end
153.
154.   if suctOutput == dischOutput then
155.     winning = 0
156.   end
157.
158.   if winning == 0 then
159.     set_gbl("PIDsuctMax",100)
160.     set_gbl("PIDdischMax",100)
161.   end
162.
163.   if winning == 1 then
```


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```
164.     set_gbl("PIDdischMax",math.min(suctOutput + 2,100))
165.     set_gbl("integraldisch",0)
166.     set_gbl("lastErrdisch",0)
167.     set_gbl("outputSumdisch",0)
168.     set_gbl("PIDsuctMax",100)
169.   end
170.   if winning == 2 then
171.     set_gbl("PIDsuctMax",math.min(dischOutput + 2,100))
172.     set_gbl("integralsuct",0)
173.     set_gbl("lastErrsuct",0)
174.     set_gbl("outputSumsuct",0)
175.     set_gbl("PIDdischMax",100)
176.   end
177.
178.   local recycleMinOutput = minOutput
179.
180.   local manOutput = 0
181.   --
     ************************************************************
     **
182.   local manMode = 0
183.   local manTerm = tonumber_def(get_gbl("manTerm",0),0)
184.   local manChan = tonumber_def(get_gbl("manChan",0),0)
185.   if manTerm > 0 and manChan > 0 then
186.     local manInput = get_channel_val(manTerm,manChan)
187.     if manInput > 0.5 then
188.       manMode = 0
189.       set_sVirt("SpeedControl","Auto")
190.     else
191.       manMode = 1
192.       set_sVirt("SpeedControl","Manual")
193.     end
194.   else
195.     if get_sVirt("SpeedControl","Auto") == "Auto" then
196.       manMode = 0
197.     else
198.       manMode = 1
199.     end
200.   end
201.
202.   --if manMode == 1 and get_state() == 8 then
203.   local manSpeed = get_sVirt("ManualSpeed",0)
204.   local idleSpeed = get_gbl("idleSpeed",0)
205.   local lowSpeed = get_gbl("lowSpeed",0)
206.   local highSpeed = get_gbl("highSpeed",0)
207.   local maxSpeed = get_gbl("maxSpeed",0)
208.   local diff = highSpeed - lowSpeed
209.   if diff < 0 then diff = 0 end
210.   local maxDiff = maxSpeed - idleSpeed
211.   if maxDiff < 0 then maxDiff = 0 end
212.
```


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```
213.   if get_sVirt("speedBump",0) ~= 0 then
214.     local si = get_gbl("SpeedIncrement",0)
215.     local sip = get_param("SpeedIncrement",0)
216.     if sip ~= 0 then si = sip end
217.     manSpeed = manSpeed + (si * get_sVirt("speedBump",0))
218.     set_sVirt("speedBump",0)
219.   end
220.
221.   if get_sVirt("AutoManBump",0) > 0 then
222.     set_sVirt("SpeedControl","Auto")
223.     set_sVirt("AutoManBump",0)
224.   end
225.
226.   if get_sVirt("AutoManBump",0) < 0 then
227.     set_sVirt("SpeedControl","Manual")
228.     set_sVirt("AutoManBump",0)
229.   end
230.
231.   if manMode == 1 then
232.     local manSpeedTerm = tonumber_def(get_gbl("manSpeedTerm",0),0)
233.     local manSpeedChan = tonumber_def(get_gbl("manSpeedChan",0),0)
234.     if manSpeedTerm > 0 and manSpeedChan > 0 then --*** USE SPEED
    POT TO SET SPEED
235.       local speedInput =
    tonumber(get_channel_val(manSpeedTerm,manSpeedChan))
236.       local speedPct = (speedInput / 5) * 100
237.       if speedPct > 100 then speedPct = 100 end
238.       if speedPct < 0 then speedPct = 0 end
239.       manOutput = speedPct
240.       manSpeed = math.floor((speedPct / 100) * diff + lowSpeed +
    0.5)
241.     else -- Use ManualSpeed to set speed
242.       manOutput = ((manSpeed - lowSpeed) / diff) * 100.0
243.       if manOutput < 0 then manOutput = 0 end
244.       if manOutput > 100 then manOutput = 100 end
245.     end
246.     minOutput = manOutput
247.   else
248.     --speedTarget =
249.     local stRpm = (speedTarget/100) * maxDiff + idleSpeed
250.     if stRpm < lowSpeed then stRpm = lowSpeed end
251.     if stRpm > highSpeed then stRpm = highSpeed end
252.     manSpeed = math.floor(stRpm)
253.   end
254.
255.   if manSpeed < lowSpeed then
256.     manSpeed = lowSpeed
257.   end
258.   if manSpeed > highSpeed then
259.     manSpeed = highSpeed
260.   end
```


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```
261.
262.   set_sVirt("ManualSpeed",manSpeed)
263.
264.
265.
266.   --
      **********************************************************************
      **
267.
268.
269.   local output1 = 0
270.   local output2 = 0
271.   if spSuctType == "pid" or spDischType == "pid" then
272.     output1 = map_range(outputLow,outputHigh,minOutput)
273.     set_sVirt("out1",output1)
274.     output2 = map_range(outputLow2,outputHigh2,recycleMinOutput)
275.     set_sVirt("out2",output2)
276.     local hasRPM = idleSpeed > 0 and lowSpeed > 0 and highSpeed >
      0 and maxSpeed > 0
277.     if outputTerm and outputChan then
278.       if hasRPM then
279.         local speedRpm = output1 / 100  * (highSpeed - lowSpeed) +
      lowSpeed
280.         speedTarget = (speedRpm - idleSpeed) / (maxSpeed -
      idleSpeed) * 100
281.       else
282.         speedTarget = output1
283.       end
284.     end
285.     if recycleTerm and recycleChan then
286.       set_ao_val(recycleTerm,recycleChan,output2)
287.     end
288.
289.     if get_state() == 9 then
290.       speedTarget = get_sGbl("speedTarget",0)
291.       if speedTarget > 0 then speedTarget = speedTarget -
      rampRate1 end
292.       if speedTarget < 0 then speedTarget = 0 end
293.     end
294.     if get_state() < 8 then speedTarget = 0 end
295.     set_sGbl("speedTarget",speedTarget)
296.     set_ao_val(outputTerm,outputChan,speedTarget)
297.     set_sVirt("spTarget",speedTarget)
298.
299.     if hasRPM then
300.       local sRpm = (speedTarget/100) * maxDiff + idleSpeed
301.       set_sVirt("Speed Target",math.floor(sRpm + 0.5))
302.     end
303.
304.
305.
```


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```
306.   else
307.
308.     -- Remember that minOutput is 0 - 100 pct of lowSpeed <->
     highSpeed
309.     -- We need to convert this to 0 - 100 pct of idleSpeed <->
     maxSpeed
310.     local suctPct = map_range(outputLow,outputHigh,minOutput)
311.     local speedRpm = suctPct / 100  * (highSpeed - lowSpeed) +
     lowSpeed
312.     minOutput = (speedRpm - idleSpeed) / (maxSpeed - idleSpeed) *
     100
313.
314.
315.
316.     if minOutput <= speedTarget then
317.       speedTarget = speedTarget - rampRate1
318.       if speedTarget < minOutput then speedTarget = minOutput end
319.     else
320.         speedTarget = speedTarget + rampRate1
321.         if speedTarget > minOutput then speedTarget = minOutput
     end
322.         if speedTarget > maxLoad then speedTarget = maxLoad end
323.     end
324.     if speedTarget > maxLoad then speedTarget = maxLoad end
325.     if speedTarget < minLoad then speedTarget = minLoad end
326.
327.     if recycleCtrl then
328.       local recyclePct =
     map_range(outputLow2,outputHigh2,recycleMinOutput)
329.       if recyclePct <= recycleTarget then
330.         recycleTarget = recycleTarget - rampRate2
331.         if recycleTarget < recyclePct then recycleTarget =
     recyclePct end
332.       else
333.         recycleTarget = recycleTarget + rampRate2
334.         if recycleTarget > recyclePct then recycleTarget =
     recyclePct end
335.       end
336.       if recycleTarget > maxRecycle then recycleTarget =
     maxRecycle end
337.       if recycleTarget < minRecycle then recycleTarget =
     minRecycle end
338.       local recycleOutput = recycleTarget
339.       if get_state() < 8 then
340.         recycleTarget = 0
341.       end
342.       if recycleRevAct == 1 then
343.         recycleOutput = 100 - recycleOutput
344.       end
345.       set_ao_val(recycleTerm,recycleChan,recycleOutput)
346.       set_sGbl("recycleTarget",recycleTarget)
```


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```
347.       set_sVirt("recycleTarget",recycleTarget)
348.     end
349.
350.     if get_state() == 9 then
351.       speedTarget = get_sGbl("speedTarget",0)
352.       if speedTarget > 0 then speedTarget = speedTarget -
     rampRate1 end
353.       if speedTarget < 0 then speedTarget = 0 end
354.     end
355.     if get_state() < 8 then speedTarget = 0 end
356.     set_sGbl("speedTarget",speedTarget)
357.     set_ao_val(outputTerm,outputChan,speedTarget)
358.     set_sVirt("spTarget",speedTarget)
359.     local sRpm = (speedTarget/100) * maxDiff + idleSpeed
360.     set_sVirt("Speed Target",math.floor(sRpm + 0.5))
361.
362.
363.   end
```

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