COMMISSIONING OF CLOSED LOOP CONTROLS AT CPP,HWP MANUGURU

By

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INTRODUCTION :

The captive power plant for heavy water plant is equipped with 3x265 T/Hr steam capacity boilers supplied by m/s ABL with 3x30 MW capacity TGs supplied by m/s BHEL; the plant also supplies 375 T/Hr of 32 ata HP steam and 15 T/Hr of LP steam to main plant (for production of heavy water). The control and instrumentation system at CPP is specified by m/s TCE, engineered by m/s ECIL (except for instrumentation of bought-out items like TG and auxiliaries,boiler furnace safeguard and supervisory system etc) and supervised by m/s TPL during installation & commissioning.
M/S ECIL have supplied DDC system of ASEA Sweden for open loop & closed loop controls, and data acquisition functions.

CONTROL PHILOSOPHY :

The control system is built around ASEA master hardware for sequence interlocks,closed loop control, and data acquisition functions.ASEA master is a distributed digital control system built around atleast 2 levels of communication networks.At the lowest level, it ties distributed programmable controllers directly to the process or machine with peer to peer communication capabilities.At supervisory level,con trols are still programmable controllers but with much higher range of control algorithms, and communication is a true data high way.External computer namely Host computer DEC PDP 11/84 is used for performance calculations,load steam management,logs and reports, and IP-11 sub-system for sequence of events recording. PDP 11/84 communicates with ASEA system via EXCOM link for plant-wide management.Total plant control is through man-machine communication color display monitors connected to ASEA supervisory control module namely Master View 850.

In each unit, there is redundancy for sequence interlocks. And for closed loop controls, there will be multiloop controllers(each of which can control 10 PIDs or 6 STARs) and one or more dedicated backup controllers(single PID) depending on the loop. Normally multiloop controller will be on line and the moment it fails, backup controller will come on line(depending on the loop complexity). Two numbers of CRTs and printers are provided per unit. The operator can use one CRT as Utility CRT for display and control function, and the other can be used as an alarm CRT or to obtain data from other units or for control of common auxiliaries. One hardcopier is provided for taking trends from any unit. A typical trend is herewith attached for reference.

BRIEF DESCRIPTION ABOUT SYSTEM HARDWARE :

The configuration for total I & C and DAS is shown in fig 1.

(a) Master View: This is man machine communication interface used for superviosory control. Masterview sends/receives data to or from Master piece and displays the information on CRTs or printers. It is also connected to a host computer for data transfer.

(b) Master Piece : Master piece is used for system interlocks and protection logic for open loop controls. Each unit has 2 Master pieces working in parallel for redundancy, and one more master piece is for data acquisition functions.

(c) Novatune : This is a multiloop controller used for closed loop controls. Each Noavatune can support 10 PIDs or 6 STARs (SElf Tuning Adaptive Regulators). This will communicate with Master Piece for orders from or indications on CRT.

(d)Backup station: This is a backup single PID controller communicating with Novatune via multidrop communication link. Each novatune can support 30 backup stations. In the event of failure of a related novatune, a backup station will take over for simple PID control function.

(e) Host computer : This is used for performance calculations, load steam management, superviosory displays, logs and report generation and sequence of events recording. Host computer is connected to ASEA master view for data transfer from master pieces.

COMMISSIONING OF CLOSED LOOP CONTROLS IN DDC SYSTEM :

In comparison to any conventional control system, DDC system will provide a lot of flexibility in doing various modifications/corrections depending on the complexity of loops. For example, providing a CRT alarm for signal errors, events for auto to manual condition, alerting an operator for big deviation between set point and measured variable, limiting the inputs/outputs etc. Operator always gets alerted by various alarms/events which otherwise would not have been possible, and also will have control display on demand to see the detailed functioning of the loop and its status, past & present.

In captive power plant, commissioning of closed loops is usually carried out in the following steps:

(a) checking of all field inputs (digital and analog) and their ranges in application software.

(b) checking of application software for confirmation to design intent; carrying necessary modifications/corrections, if required, for better operational facility or for better control,

(c) checking the final control element (motor operated valves) operation from backup station for capability of its opening and closing,

(d) during cold checks, simulating various conditions in software/inputs, and looking for the occurrence of events/alarms, auto to manual transfer, indications on CRT, orders from CRT etc,

(e) after completing the above exercises, loop is tuned by any of the tuning methods (trial and error, Ziegler and Nichols, reaction curve) when process is available and load *is above* 50 %.

Commissioning of a typical control loop is given below:

Deaerator Pressure Control Loop:

This loop controls the deaerator pressure by modulating the deaerator pegging steam control valve in the 8 ata steam supply line.

(1) Calibrate Deaerator pressure transmitter, valve position transmitter and check their ranges in application software.

(2) Check whether control valve feedbacks (namely torque limits and position feedbacks) are coming correctly to the system.

(3) Check whether Object Control Display for pressure control is available on both unit and common CRTs.

(4) By changing the Alarm limits for measured variable H1,L1 from object display see whether alarms are coming in alarm list and also on object display.

(5) By changing the Alarm deviation (deviation between measured variable and set point) limit, see whether alarm is appearing on CRT and object display.

(6) By switching off the Novatune or backup station or communication failure, see whether Novatune system alarm is

appearing in alarm list and also on object display.

(7) By varying the setpoint/output high/low limits from CRT see whether events are coming on event list and also on object display.

(8) Check whether Backup Station manual, local, remote modes are reflected correctly on CRT object display by effecting it from Backup Station.

(9) Check whether the following points are satisfied for throwing the loop to 'Auto'.

i. measured variable signal error is not there (i.e.check for non-conformance of +110% MV range < signal value < -10% MV range)

ii. Control valve position feedback error is not there. (i.e check for non-conformance of +110% < position feedback value < -10%).

iii. 415 volts module overload trip is not there.

iv. Communication between Novatune and Backup Station is healthy

v. Alarm deviation is not there (i.e. check for non-conformance of 3kg/cm2 < deviation between MV and SP < -3kg/cm2)

(10) Throw the loop to Auto by command from CRT and simulate the following conditions, one by one, for throwing the loop to manual.

i. Measured variable signal error.

ii. Position feedback error

iii. Module trip

iv. Communication not healthy

v. Throwing the loop from CRT by giving MAN Command

vi. Throwing the loop to Manual from BS-20.

(11) When process is available and load is above 50 %, maintain the measured variable at required setpoint manually for some time, and then by trial and error method tune the loop by changing the PID values in application software. It is easy to commission a loop as we get a 4 minute trend of measured variable, set point and valve position on object display for analysis. It is possible to get one/eight/twenty-four hours trends also if required for analysis purposes.

PROBLEMS FACED IN THE COMMISSIONING OF CLOSED LOOPS :

(a) Field Problems: Water seeping into motor junction boxes and other junction boxes causing unwanted behavior of loops. The junction boxes supplied &/or their installation were not satisfactory. The problem was rectified by covering the junction boxes with hoods and application of water resistant compound to unsatisfactory joints.

(b) Grounding Problem : Backup station displays measured variable and position feedback of control valve on it. Sometimes it used to display some random values for measured variable and feedback. Later it was found that backup station signal ground was not connected to power supply ground. The problem was rectified by grounding the signal ground points of all backup stations.

(c) Sensitivity of measurements : Since all measurements are being done by electronic transmitters and final control is by motor actuators, control is very sensitive. So the loops are made relatively insensitive by dampening the transmitters, not allowing the loop to function upto a certain deviation between measured variable and set point and by reducing the external gain of BS integrator.

(d) ASEA system problems : During commmisioning,a number of problems have been encountered in ASEA system as it is a newly introduced process control system in power industry.Typical problems are summarised below:

i. Tuning of loops: Loops are tuned using standard methods like Zeiglar-nichols,trial and error etc but results are not as expected.

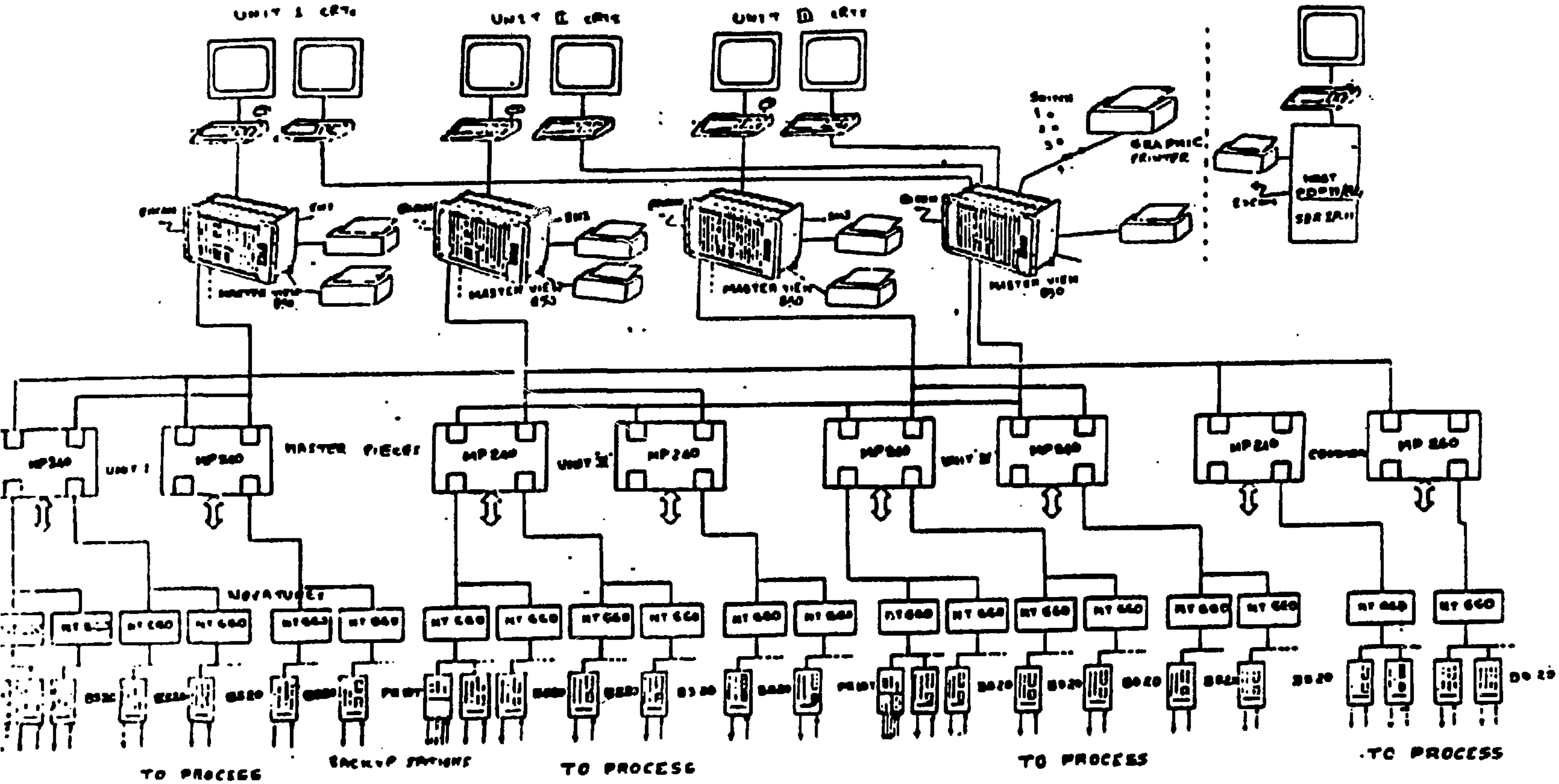
ii. Failure of cards : During commissioning a good number of cards failed which could not be diagonised due to lack of sufficient information/expertise in this field within the country.

iii. Other typical problems : Problems like stalling of system,communication failure,loops throwing to manual etc have occured frequently hampering smooth commissioning and sometimes leading to unwanted trips.

CONCLUSION :

Due to lack of expertise from m/s ECIL's commissioning group on ASEA DDC system as well as on instrumentation of power plants,the loop tuning could not be carried out to the level of satisfaction desired. Moreover, no training had been imparted to the client nor the documents provided are sufficient to execute the job satisfactorily.Based on the observations on behaviour of loops for long time, adjustments/assumptions have been made on various control parameters to bring the band of process variable to an optimum level.

To , make such a sophisticated control system to work satisfactorily proper training of the user's concerned personnel is very much essential.A dedicated group from the client should be involved right from design stage,software development till commissioning and performance guarantee run.The number of agencies involved should be as minimum as possible to avoid loss of vital information at various stages and to execute the job satisfactorily within a time frame.



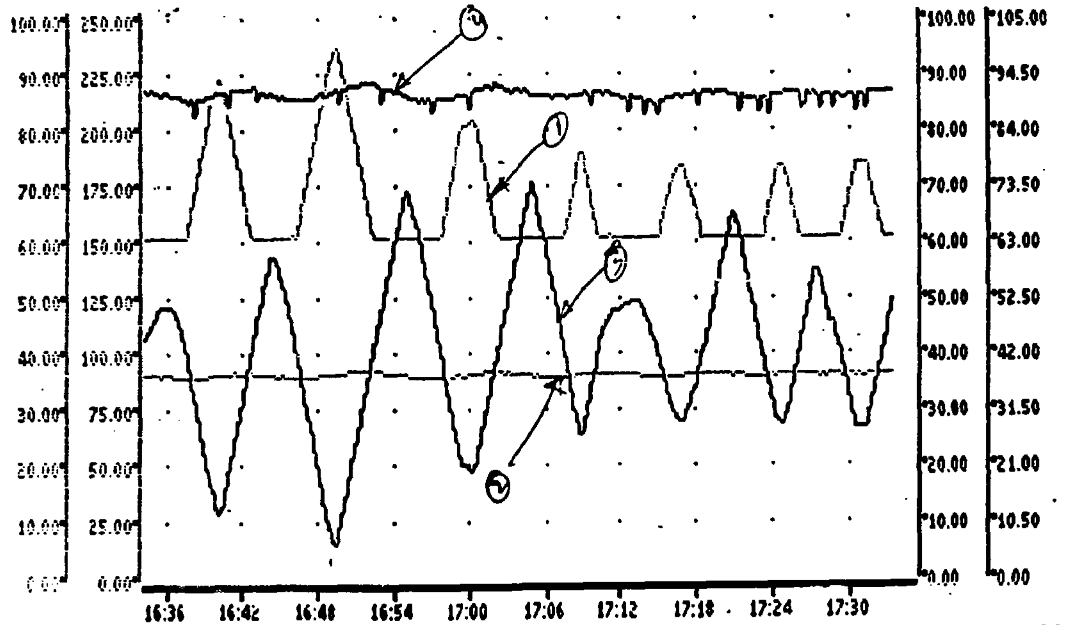
ASEA CONFIGURATION

Fig. 1

TREND CURVES

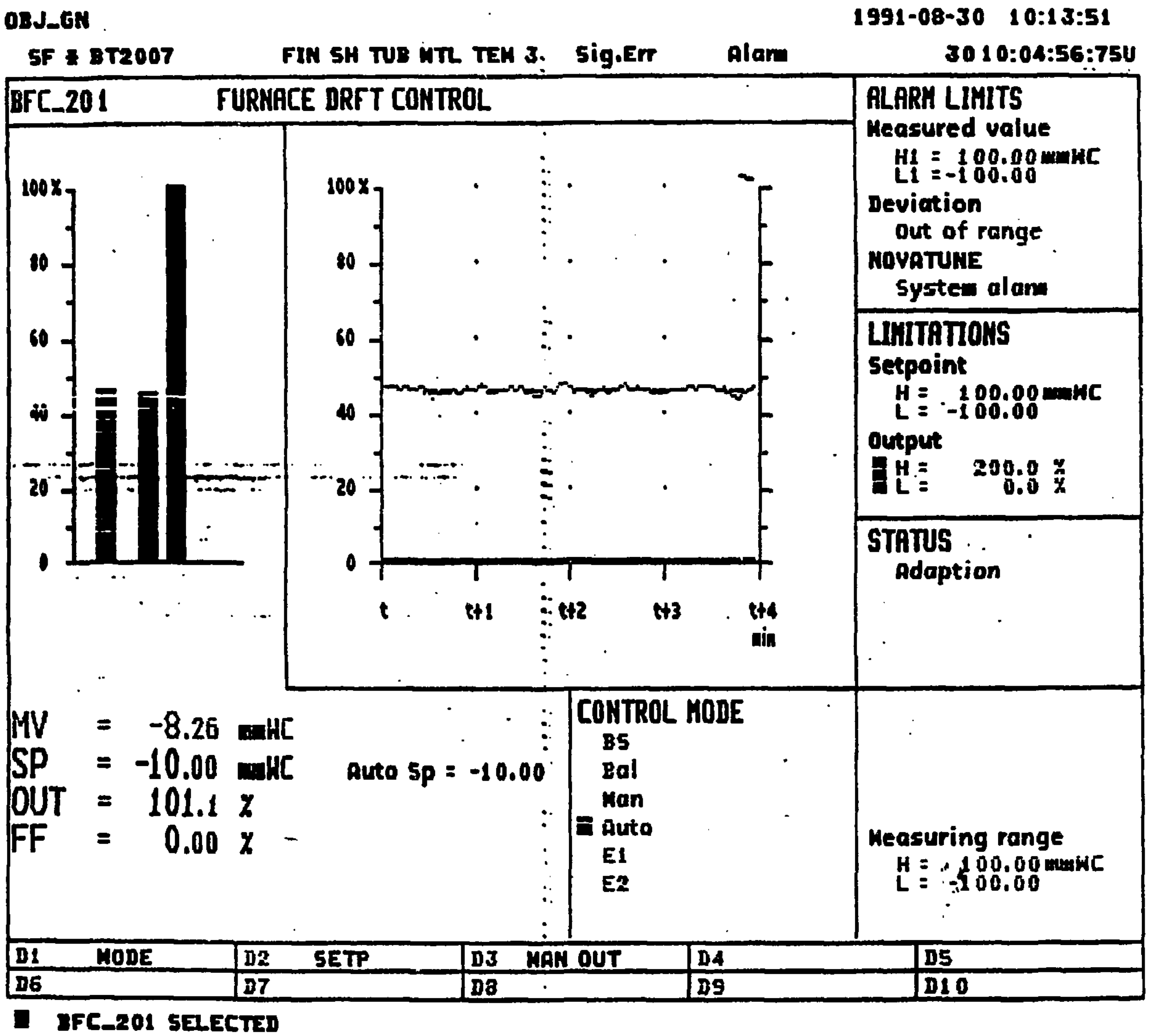
TREND.12 MILL D TEMP CTRL Unit = 1 1991-11-28 17:33:31

F01001 HFO HTR OUT TEMP ?? NORMAL 28 17:31:35:58



91-11-28 17:33:00

LO1H155.5	LO1H155.5	LO1H155.5	LO1H155.5
Mom	Mom	Mom	Mom
AP1012 MV	CH1011 MV	AP1008 MV	CH1408 (coal (hot air)) MV
① D32 POSITION (hot air)	② MILL D CL-AIR TEMP	③ D28 POSITION (cold air)	④ MILL 1D C-AIR AV
60.52 X	90.26 DEG.C	49.36 X	90.83 DEG.C


OBJ_GN
1991-08-30 10:13:51
SF # BT2007
FIN SH TUB MTL TEM 3
Sig.Err
Alarm
30 10:04:56:75U
BFC_201
FURNACE DRFT CONTROL
100%
80
60
40
20
0
t
t+1
t+2
t+3
t+4
min
ALARM LIMITS
Measured value
H1 = 100.00 mmWC
L1 = -100.00
Deviation
Out of range
NOVATUNE
System alarm
LIMITATIONS
Setpoint
H = 100.00 mmWC
L = -100.00
Output
H = 200.0 %
L = 0.0 %
STATUS
Adaption
MV = -8.26 mmWC
SP = -10.00 mmWC
OUT = 101.1 %
FF = 0.00 %
Auto Sp = -10.00
CONTROL MODE
BS
Bal
Man
Auto
E1
E2
Measuring range
H = 100.00 mmWC
L = -100.00
D1 MODE
D2 SETP
D3 MAN OUT
D4
D5
D6
D7
D8
D9
D10
BFC_201 SELECTED

3.5

INPUTS/OUTPUTS

	Open loop		Closed loop	
	Unit	common	Unit	common
DI	1317	541	190	48 *
DO	160	50	64	20
AI				
4-20 mA	192	112	44	
T/C	70	14	-	- **
RTD	124	31	-	-
AO	8		10	

<u>BS-20:</u>

AI	-	-	71	21 **

* Total 5128 for 3 units inclusive of 1021 for redundancy in Open loop control.

** Total 1781 for 3 units and Common

MASTERVIEW

a. KEYBOARDS:

1) Functional - for the operator.

2) Design - for the designer to create new displays and edit old ones.

b. DISPLAYS:

1) Process mimics - user defined

2) Group display - All devices coming under one group e.g. BFP group.

3) Object display - for each object.

4) Event list - All operator actions, alarm limit transgressions return to normal mode change over pumps running/stopped, trip conditions etc.,

5) Alarm list - pump tripped, limit transgressed etc.,

Alarms and events are indicated with the following details

i) Identity tag
ii) Blinking * for unacknowledged alarm
iii) Description
iv) Type of events/alarms
v) Time of occurence

OPERATOR COMMANDS:

Following commands can be given from the key board:

- Pumps on/off
- Valves open/close
- Set point increase/decrease
- Manout increase/decrease

DISPLAY DESIGN:

- Using the symbol library, new diaplays can be built up
- New symbols can also be created using the symbol editor

TRENDS:

- Historical trends of 1hr, 8hrs, 24 hrs and 240 hrs duration can be configured for any parameter.

- A Maximum of 20 kpages of trneds with each page accommodating 4 parameters is possible.

DISPLAY STORAGE:

- All displays are stored in a set of Nine 5 1/4" floppies

MASTERPIECE

All the pumps, valves and dampers open/close, on/off logic interlocks are performed in MASTERPIECE MP 240/260.

The database for the Digital Inputs, Digital Outputs, Analog inputs and Analog outputs; General objects, data sets etc., are stored in the MASTERPIECE.

The programming is done using a programming unit MA214 which is connected to the MASTERPIECE by an RS232C link.

The programmes and database are stored on floppy discs.

Masterpiece also acts as a communication link between MASTER-VIEW and NOVATUNE Multiloop controllers.

NOVATUNE
(MULTILOOP CONTROLLER)

The closed loop schemes for the following are configured in the Novatunes.

- Combustion control
- Airflow control
- Furnace draft control
- Coal mill temp.control
- Super heated steam temp. control
- Boiler drum level control
- Recirculation valve control
- Hotwell level control
- Deaerator level control
- CBD tank level control
- HPPRDS pressure and temp.control
- LPPRDS pressure and temp.control

Out of the above, last two controls are realised in two Novatunues under common services.Rest of the controls are required in every unit and are realised through 6 Novatunes in each unit.

Novatune communicates upwards with Masterpiece on an RS422 like link (Master bus) and downwards with the BS20s through an RS232C/RS422 link.

The application programme generates alarms for the process variable valve position, auto/manual selection, PID/STAR control, setpoint selection etc.,

BACKUP STATION

The backup station BS20 is the final interfacing element between the Novatune and the field.

It accepts the following analog inputs:

- Process variable
- Actuator position feedback
- Auxiliary input

It generates the following digital outputs:

- Increase (DO1)
- Decrease (DO2)

Depending upon the position, demand signal and position feedback signal pulses of varying width are generated, to control the actuator. BS20 has got three modes of operation, namely:

- Remote, local and manual

In remote mode both the setpoint and the controller output are from the Multiloop controller.

In local mode the setpoint is local to the BS20 but the controller output is from the Novatune.

In manual mode there is no setpoint involved and the operator decides the valve position locally from the BS20.

THYRISTOR REVERSING SWITCH MODULE

If the phase sequence at the output is U,V,W with increase on, then it changes to U,W,V with decrease on.

The outputs to the motor are fused.

Thermal overload protection is also provided.

The occurence of both the INC & DEC pulses simultaneously is inhibited.