National Centre for Radio Astrophysics

Internal Technical Report

Analysis and comparison of OLD PMAC(from m/s Maccon) and NEW PMAC (from m/s Delta tau)

Giant Metrewave Radio Telescope

Tata Institute of Fundamental Research

Document Status Record S.No	**Document Status**	**Description**
1	Document Title	Analysis and comparison of OLD PMAC(from M/S Maccon) and NEW PMAC (from M/S Delta tau)
2	Document Reference No.	GMRT/SERVO/PMAC/001 – SEPT 2013
3	Revision	0.1
4	Date	23rd Sept-2013
5	Prepared By	Abhishek Pawar, Shailendra Bachal
6	Reviewed By	Servo Group Members
7	Approved By	

Contents

I variable configuration

Basic I variable's configured are same for both the PMAC

I Variable	Value	Description
I100	**1**	To activate motor 1 connected
I8000	**$78000**	Conversion table setup line. Configures 1/T extension of Encoder 1. $ represents value is in hexadecimal
Ixx24 (I124) For motor 1	**$20001**	Motor Flag control mode. Configured for PMAC2 style servo IC. Hardware position limits are disabled
I7mn6(I7016) For servo IC 0 channel 1	**1**	Channel output configured as DAC output instead of PWM
Ixx03 (I103) For motor 1	**$3501**	Position loop feedback address configured for configured for conversion table line 0
Ixx04 (I103) For motor 1	**$3501**	Velocity loop feedback address configured for configured for conversion table line 0

DAC Calibration test

We are using output channel of PMAC in DAC mode (Refer I7mn6 variable mentioned earlier). DAC offset can be compensated for with Ixx29.

Procedure to calibrate DAC manually,

1. Issue a #1o0 command(zero percent torque command). If there is an offset motor will start rotating
2. If the motor moves in the positive direction, decrease Ixx29 appropriately until #no0 produces no motion
3. If the motor moves in the negative direction, increase Ixx29 appropriately until #no0 produces no motion

OLD PMAC	NEW PMAC
I129=-100	I129= -90

Inference from above test:

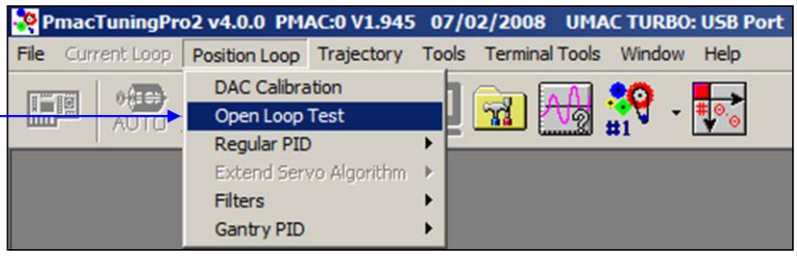
By changing value of Ixx29 initial offset of PMAC DAC output channel (Which is connected to Analog input channel of Servostar) can be minimized

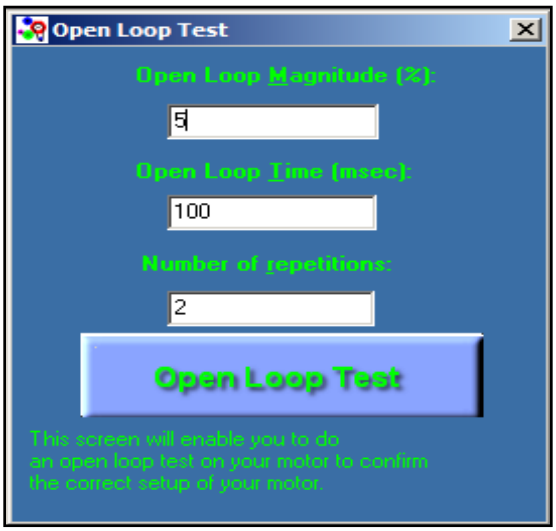
Open loop test

Purpose of open loop test

The Open Loop Test makes sure that when outputting positive command, the encoder position count also goes up.

Open Loop Test Tool

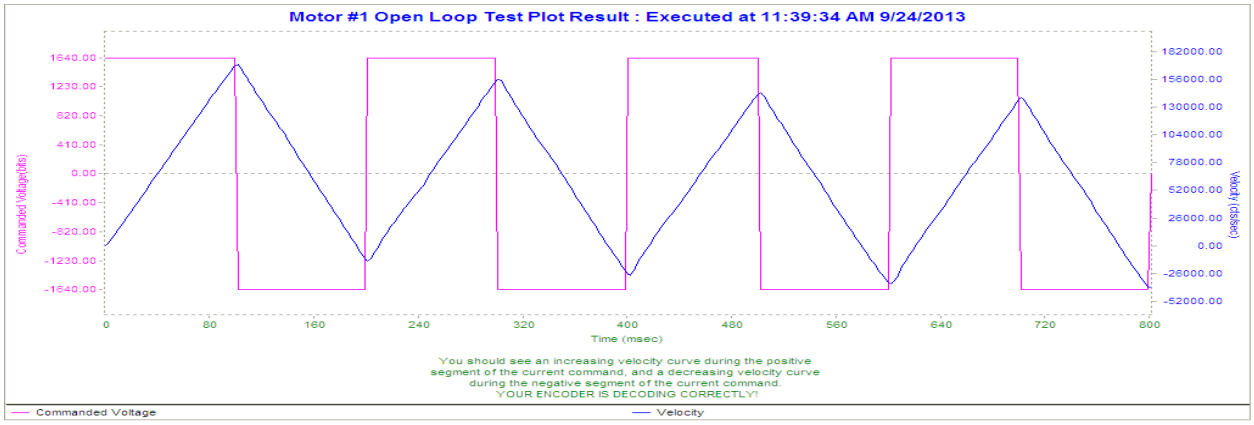




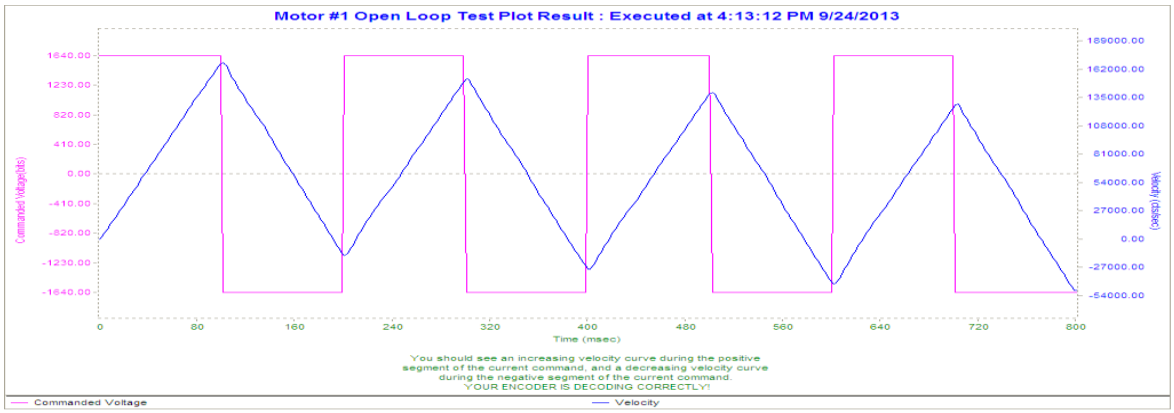
I variable to be configured in PeWin32-pro terminal window for doing open loop test

I variable	Value	Description
I7mn6 (I7010)	**3**	x4 quadrature decode CW. **x4 quadrature decode**: Signfies multiplication of counts per revolution it gets from Servostar by 4 Counts per revolution in SS: 4096 Counts per revolution in PMAC: 16384 (4096*4) **CW:** Refer plot given

New PMAC plot



Old PMAC plot



Inference from open loop test

For positive segment of current command voltage increasing velocity curve is observed, and a decreasing velocity curve during the negative segment of the current command.

In above graph,

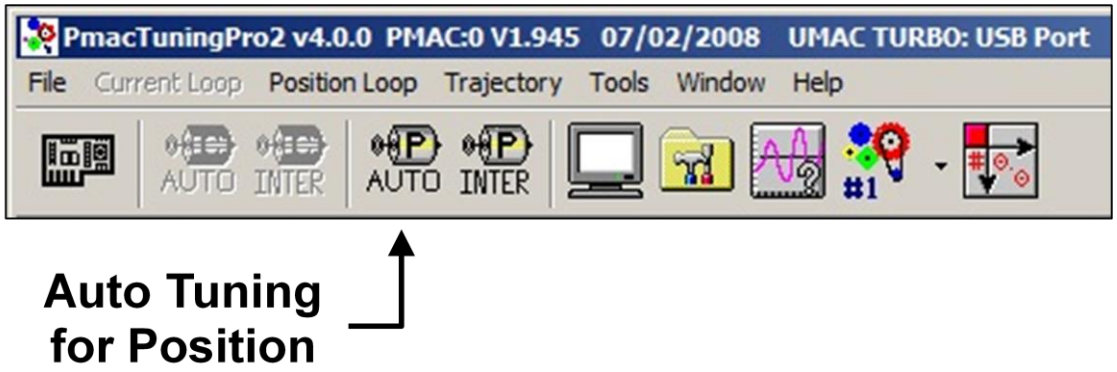
Current command voltage is represented by square wave

Velocity curve is represented by triangular wave

Tuning PMAC

Auto Tuning

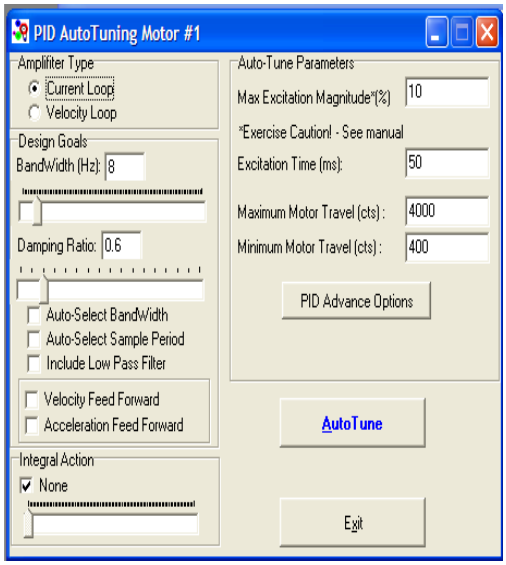
Under PEWIN32PRO2, Tools menu, PMAC Tuning Pro2



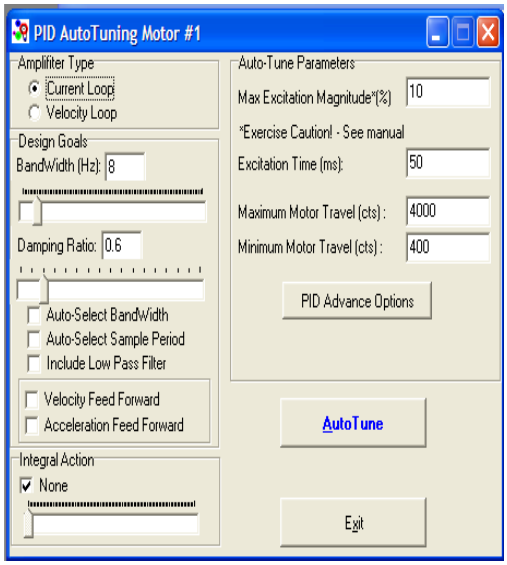
Following steps are done as part of tuning process. Comparative plots and images are given along with steps for old and new PMAC

1. Preliminary parameters setting:

New PMAC

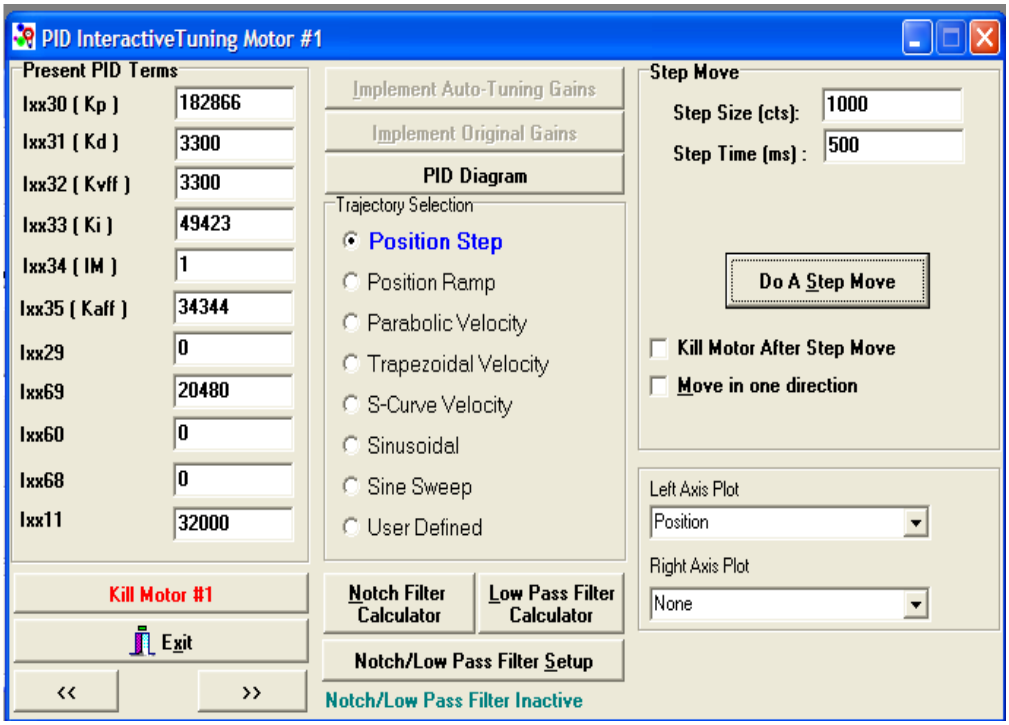


Old PMAC

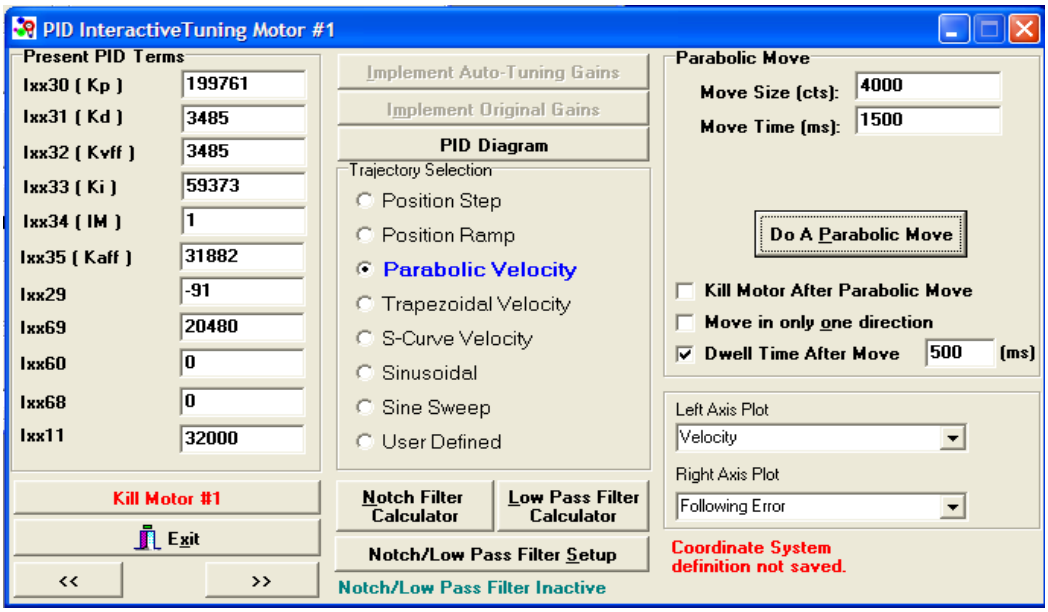


2. Click on Auto tune button gives required PID values for PMAC

New PMAC

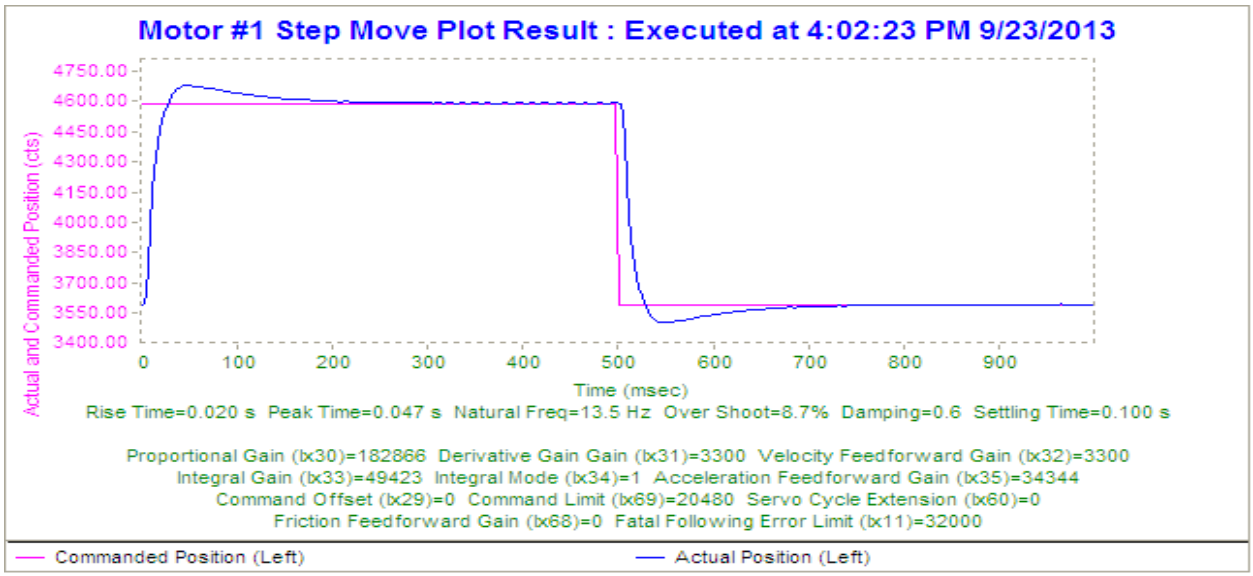


Old PMAC

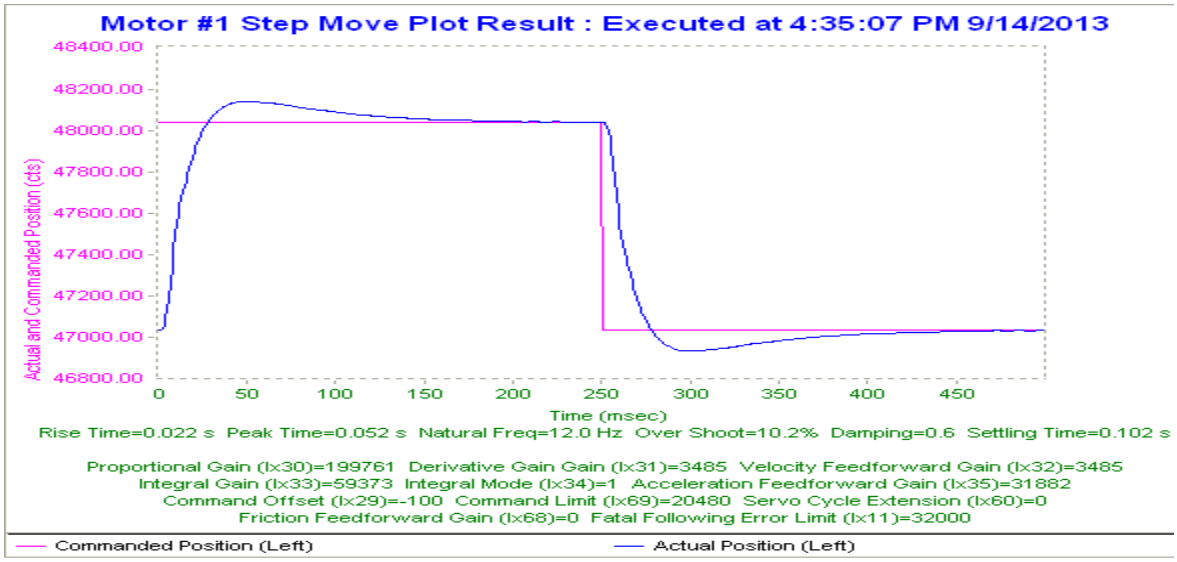


3. Once required PID values are obtained give ‘Do a Step move’ command to get step response

New PMAC



Old PMAC



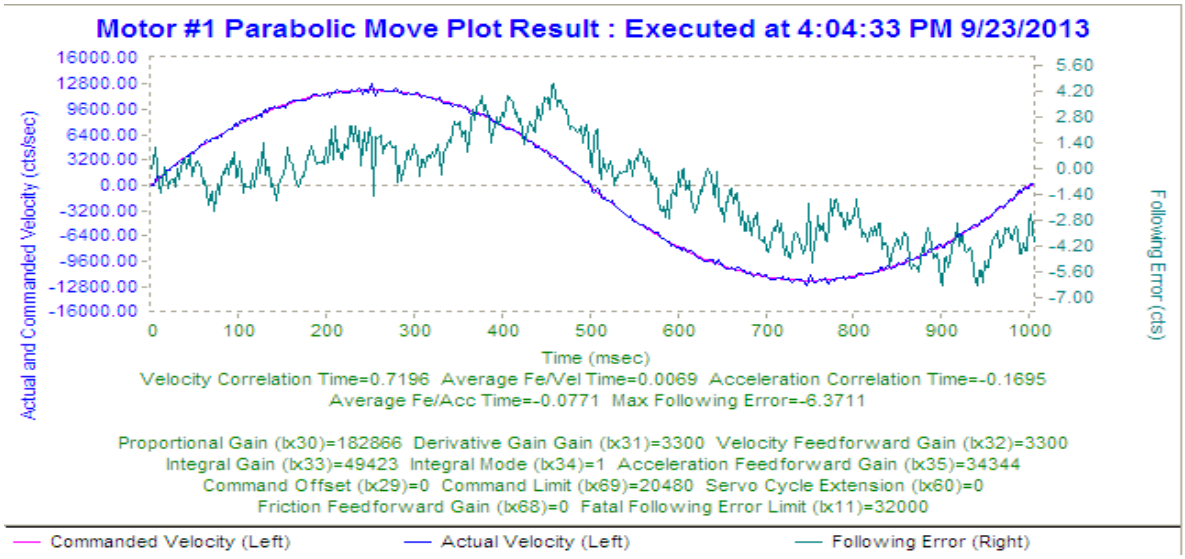
Inference from Step response test

Plot shows Actual and Commanded **position** on Y-axis with respect to **time** on X-axis. From step response plot obtained it can be seen that transient parameters measured (peak overshoot, Tr, Tp) for new PMAC is within permissible limits.

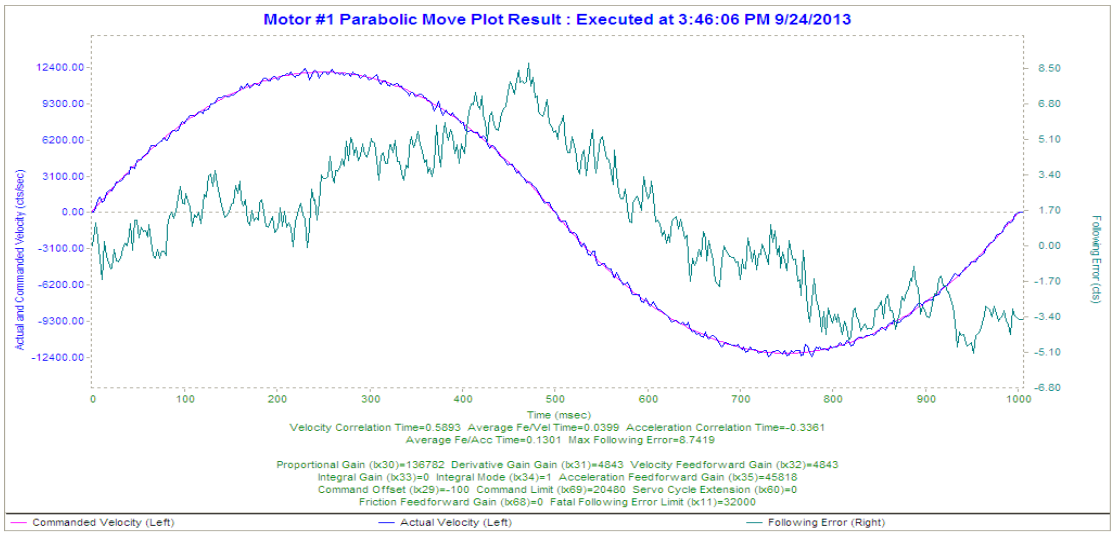
Response can be fine tuned further by changing PID gain values.

4. Give ‘Do a Parabolic move’ to obtain Parabolic response

New PMAC



Old PMAC



Inference from parabolic response test

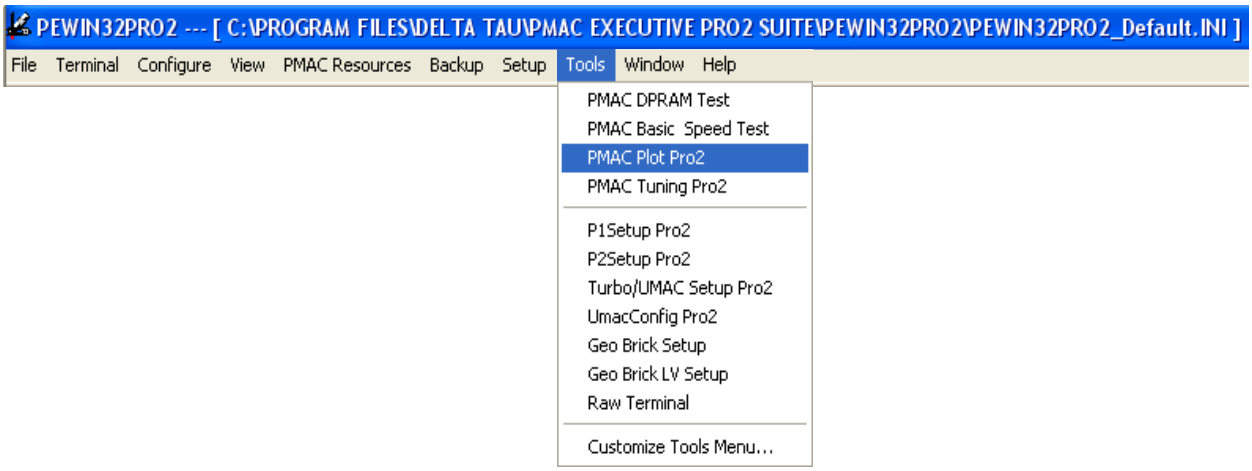
Plot shows Actual and Commanded **velocity** on Y-axis with respect to **time** on X-axis. Difference between Actual and Commanded velocity (i.e) **following error** is also plotted. Scale for following error is magnified for better understanding. Axis for following error is on right hand side of plot.

Data gathering

PMAC can acquire data from any of its memory addresses at a sampling period as low as the servo period (I variable used: I5049)

PMAC can upload gathered data to the host software to generate plots and tables to be used for analysis

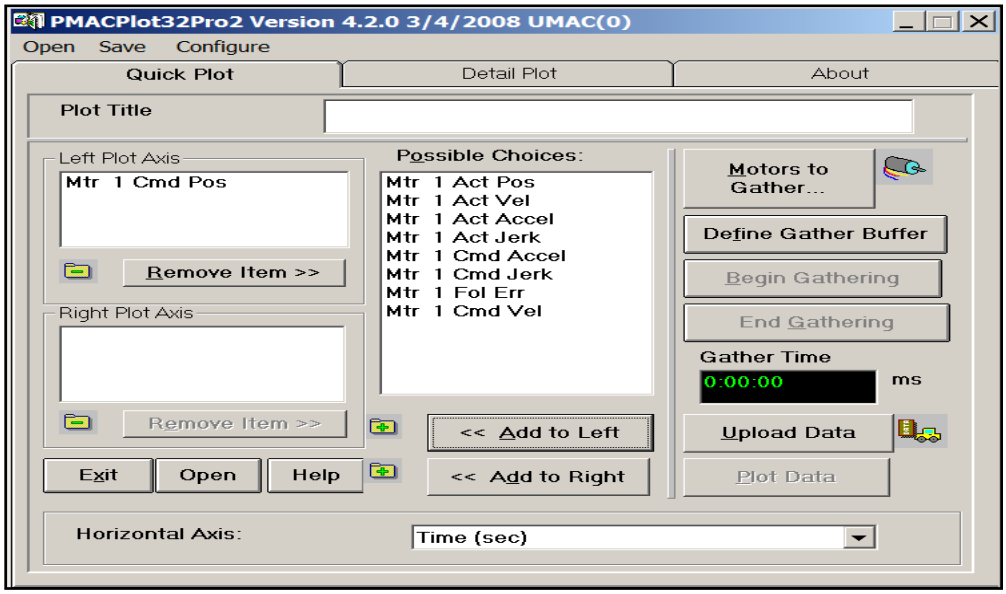
From within PeWin32Pro2, click Tools→PMAC Plot Pro2:



Gathering within a Motion Program

Procedure:

- On the Quick Plot screen, choose to plot “Mtr 1 Cmd Pos” on the Left Plot Axis by clicking on it and then “Add to Left”.



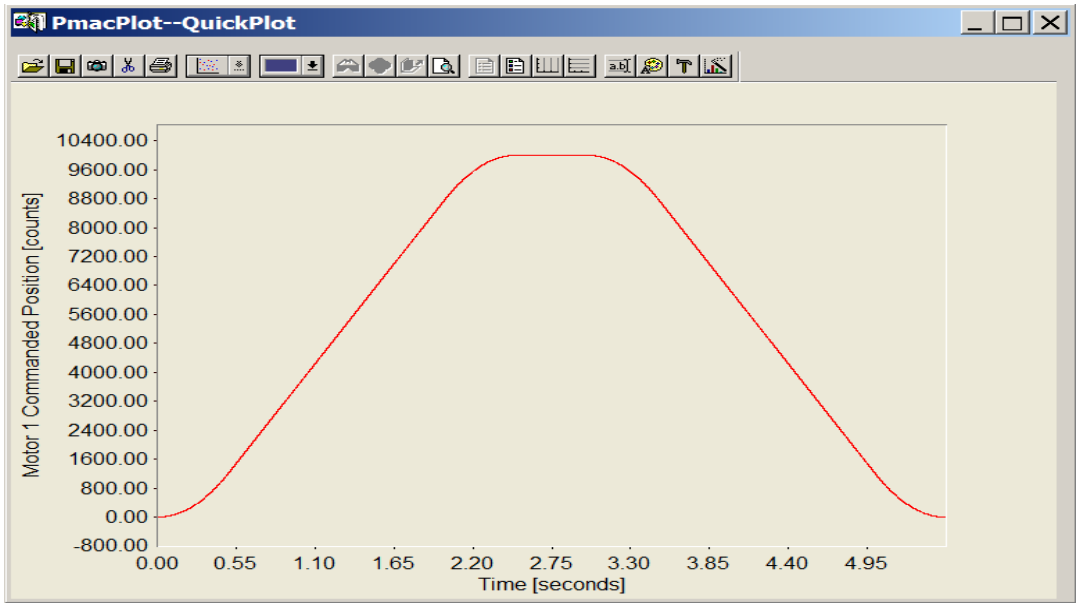
- Then, minimize the window, open a new Editor window, and download the code given below on to the PMAC.

```
/********************** Set-up and Definitions **********************/
Undefine All ; Undefine all coordinate definitions
End Gat; End any data gathering that might be happening presently
Del Gat; Erase any defined gather buffer
Close           ; Make sure all buffers are closed
&1              ; Coordinate System 1
#1->1000X       ; Assign motor 1 to the X-axis - 1 program unit
                ; of X is 1000 encoder counts of motor #1

/********************** Motion Program Text **************************/

Open Prog 1 Clear ; Open buffer for program entry, Program #1
Linear          ; Blended linear interpolation move mode
Abs             ; Absolute mode - moves specified by position
TA 500          ; Set 1/2 sec (500 msec) acceleration time
TS 0            ; Set no S-curve acceleration time
F 5             ; Set feedrate (speed) of 5000 units(cts)/sec
CMD"End Gat"    ; Stop gathering
CMD"Del Gat"    ; Deletes the gather buffer
CMD"Def Gat"    ; Allocates all the available memory as gather buffer
Dwell 0         ; Force CMD lines to execute
CMD"Gat"        ; Starts gathering of the data
Dwell 0         ; Force CMD lines to execute
X 10            ; Move X-axis to position 10000
Dwell 500       ; Stay in position for 1/2 sec (500 msec)
X 0             ; Move X-axis to position 0
Dwell 0         ; Force CMD lines to execute
CMD"End Gat"    ; Send On-line command to stop data gathering
Dwell 0         ; Force CMD lines to execute
Close           ; Close buffer - end of program
```

- Click ‘Begin gathering’ to start gathering of data in plot pro window
- Run the program by entering **&1 b1 r** into the Terminal window
- Click on ‘End gathering’ to stop gathering and then upload data using “Upload Data”
- Then, click “Plot Data”, and the following plot should load:



Inference from data gathering procedure and plots

Procedure to gather data and plot it using plot pro utility is same for new PMAC. Various parameters like motor velocity, position, acceleration and following error can be plotted using Plot-pro utility of PMAC.

Conclusion:

Preliminary tests done using New PMAC gives satisfactory results.

On account of this we can release payment to M/S Delta tau data systems India pvt. Ltd.

Further test includes integrating New PMAC into Antenna BLDC rack and loading Antenna PLC codes. This test will be done as soon as next BLDC rack is assembled.