

# *k*BLOCKS Package

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## I. INTRODUCTION

Welcome to the demo documentation of *k*BLOCKS. Desiring to typeset control block diagrams in  $\LaTeX$  and dissatisfied with the other  $\LaTeX$  macro packages that can be found online, I thought: *why not write my own macro package for this purpose.*

I wish to start with the question, “What is *k*BLOCKS?” The *k*BLOCKS macro package is the product of using TikZ/PGF to directly typeset beautiful control block diagrams and signal flow graphs in my Masters’ dissertation and papers directly with  $\LaTeX$ . Basically, it just defines a dedicated “kblock” environment and a number of macro commands to make drawing control block diagrams with TikZ/PGF more structured and easier. In a sense, when you use *k*BLOCKS you *program* or typeset graphics for control block diagrams, just as you “program” graphics in your document when you use  $\LaTeX$  using TikZ/PGF.

The powerful options offered by TikZ/PGF often intimidates beginner users not ready to spend careful time learning about TikZ/PGF. Like all  $\LaTeX$  packages, TikZ/PGF inherits the steep learning curve of  $\LaTeX$ , that is, no *what you see is what you get*. The *k*BLOCKS macro reduces the length of this learning curve, by focusing the graphics theme on control block diagrams only.

Fortunately this documentation as it grows and gets to be improved, will come with a number of demos and proper documentation of the *k*BLOCKS API, which will guide you on creating control block diagrams with *k*BLOCKS without your having to read the TikZ/PGF manual.

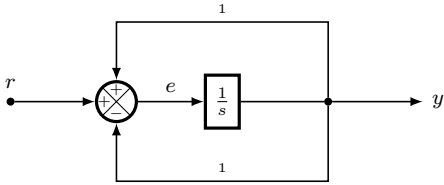
My wish is that you do find it useful and helpful.

Please, don’t forget to share and star the Github repo: <https://github.com/somefunAgba/kblocks> , if you did.

I will readily welcome any issues or emails for improvement or suggestion with respect to using *k*BLOCKS and making it useful for researchers, students and others involved in the applications and field of control theory and signal processing.

## II. DEMOS

## A. Ex:A

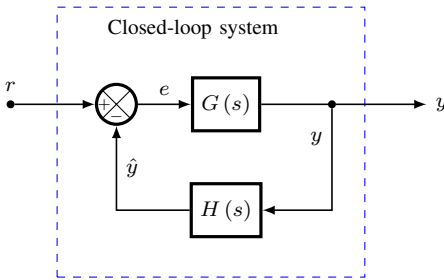


```

1 \begin{kblock}
2 % global ref point
3 \kJumpCS{init}
4 %% blocks
5 \kMarkNodeRight{0.2cm}{0cm}{r$}{init}{rin}
6 \kPlusPlusMinus{rin}{sb1}{0.2cm}
7 \kTFRight[0.2cm]{sb1}{tfb1}{\frac{1}{s}$}
8 \kMarkNodeRight{0.2cm}{0cm}{tfb1}{ny}
9 \kOutRight[0.2cm]{ny}{yout}{y$}{0cm}
10 %% links
11 \kLink[]{rin}{sb1}
12 \kLink[$e$]{sb1}{tfb1}
13 \kLinkn[]{}{tfb1}{ny}
14 \kLinkVHHVBelow[0cm]{$1$}{ny}{sb1}{0cm}{0cm}
15 \kLinkVHHVAbove[0cm]{$1$}{ny}{sb1}{0cm}{0cm}
16 \end{kblock}

```

## B. Ex:B

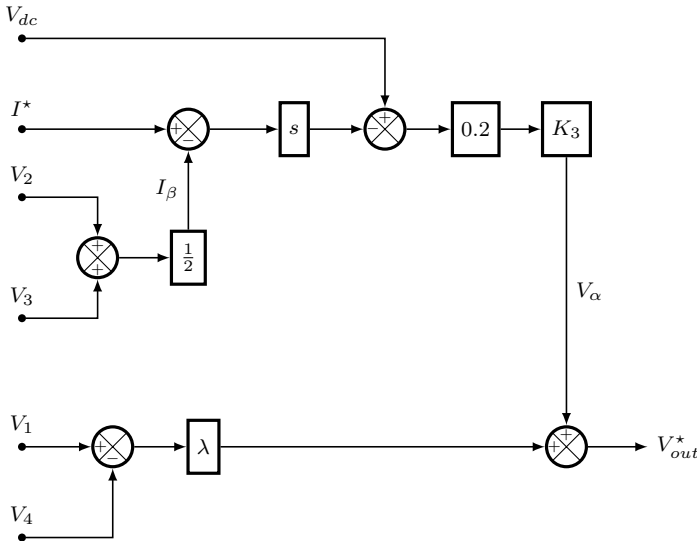


```

1 \begin{kblock}
2 % global ref point
3 \kJumpCS{init}
4 %% blocks
5 \kMarkNodeRight{0.2cm}{0cm}{r$}{init}{rin}
6 \kPlusMinusDown{rin}{sb1}{0.2cm}
7 \kTFRight[0.25cm]{sb1}{tfb1}{G\left( s \right)$}
8 \kTFBelow[0.2cm]{tfb1}{tfb2}{H\left( s \right)$}
9 \kMarkNodeRight{0.2cm}{0cm}{tfb1}{ny}
10 \kOutRight[0.2cm]{ny}{yout}{y$}{0cm}
11 %% links
12 \kLinkVH[$y$]{ny}{tfb2}{0cm}{0cm}{0cm}{}
13 \kLinkHV[$\hat{y}$]{tfb2}{sb1}{0cm}{0cm}{9}{}
14 \kLink[]{rin}{sb1}
15 \kLink[$e$]{sb1}{tfb1}
16 \kLinkn[]{}{tfb1}{ny}
17 %% coverings
18 \kCoverRect[blue]{sb1}{1cm}{2cm}{0.5cm}{3cm}
19 \kCoverTextLeft[2cm]{1cm}{covtx}{Closed-loop system};
20 \end{kblock}

```

## C. Ex:C

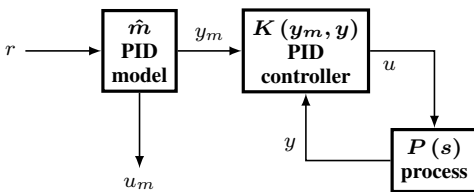


```

1 \begin{kblock}
2 % ref
3 \kJumpCS{spt}
4 % top blocks
5 \kMarkNodeRight{0cm}{0cm}{I^{\star}}{spt}{inI}
6 \kPlusMinusDown{inI}{sb1}{1.cm}
7 \kTFRight[0.2cm]{sb1}{tfb1}{s}
8 \kTFBelow[0.5cm]{sb1}{tfb2}{\frac{1}{2}}
9 \kPlusDownPlusUpL{tfb2}{sb2}{0cm}
10 \kMinusPlusUp{tfb1}{sb3}{0cm}
11 \kTFRight[0cm]{sb3}{tfb3}{0.2}
12 \kTFRight[0cm]{tfb3}{tfb4}{K_3}
13 \kMarkNodeAbove{0cm}{0cm}{V_{dc}}{inVdc}
14 \kMarkNodeBelow{0cm}{0.3cm}{V_2}{inV2}
15 \kMarkNodeBelow{0cm}{-0.4cm}{V_3}{inV3}
16 % bottom blocks
17 \kMarkNodeBelow{3cm}{0cm}{V_1}{inV1}
18 \kPlusPlusUpB{tfb4}{sb4}{3cm}
19 \kPlusMinusDown{inV1}{sb5}{0cm}
20 \kTFRight[0cm]{sb5}{tfb5}{\lambda}
21 \kOutRight[0cm]{sb4}{outV}{V_{out}^{\star}}{0cm}
22 \kMarkNodeBelow{0cm}{0cm}{V_4}{inV4}
23 % top links
24 \kLinkHV[{}inVdc]{sb3}{0cm}{0}{0}
25 \kLinkHV[{}inV2]{sb2}{0cm}{0cm}{0}
26 \kLinkHV[{}inV3]{sb2}{0cm}{0cm}{0}
27 \kLink[{}inI]{sb1}
28 \kLink[{}tfb1]
29 \kLink[{}I_{\beta}]{tfb2}{sb1}
30 \kLink[{}tfb1]{sb3}
31 \kLink[{}sb2]{tfb2}
32 \kLink[{}sb3]{tfb3}
33 \kLink[{}tfb3]{tfb4}
34 \kLink[{}V_{\alpha}]{tfb4}{sb4}
35 % bottom links
36 \kLink[{}inV1]{sb5}
37 \kLink[{}sb5]{tfb5}
38 \kLink[{}tfb5]{sb4}
39 \kLinkHV[{}inV4]{sb5}{0cm}{0cm}{0}
40 \end{kblock}

```

## D. Ex:D

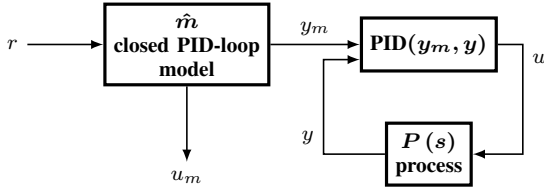


```

1 \begin{kblock}
2 % ref
3 \kJumpCS{ioref}
4
5 % blks
6 \kTFRight[0cm]{ioref}{tfb1}{
7 \bm{\hat{m}}\textbf{PID}
8 \textbf{model}}
9 \kTFRight[1cm]{tfb1}{tfb2}{\bm{K}\left(y_m,y\right)}$
10 \textbf{PID}\textbf{controller}}
11 \kTFBelowRight{0.25cm}{0.5cm}{tfb2}{tfb3}
12 {\bm{P}\left(s\right)}\textbf{process}}
13
14 % links
15 \kInLeft[0cm]{tfb1}{inR}{r}{0cm}
16 \kOutDown[0cm]{tfb1}{outU}{u_m}{0cm}
17 \kLink[{}y_m]{tfb1}{tfb2}
18 \kLinkHV[{}u]{tfb2}{tfb3}{0cm}{0cm}{1}
19 \kLinkHV[{}y]{tfb3}{tfb2}{0cm}{0cm}{4}
20 \end{kblock}

```

## E. Ex:E

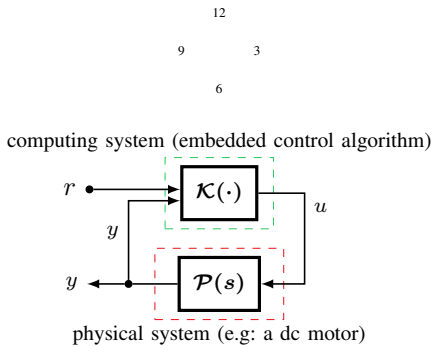


```

1 \begin{kblock}
2 % ref
3 \kJumpCS{refpt}
4
5 % blks
6 \kTFRight[0cm]{refpt}{tfb1}{
7     $\bm{\hat{m}}$\\textbf{closed PID-loop}
8     \\textbf{model}}
9 \kTFRight[2cm]{tfb1}{tfb2}{\textbf{PID}$\bm{(y_m,y)}$}
10 \kTFBelow[0.25cm]{tfb2}{tfb3}
11 {$\bm{P\left(s\right)}$\\textbf{process}}
12
13 % links
14 \kInLeft[0cm]{tfb1}{inR}{$r$}{0cm}
15 \kOutDown[0cm]{tfb1}{outU}{$u_m$}{0cm}
16 \kLink[$y_m$]{tfb1}{tfb2}
17 \kLinkHVHRight[0]{$u$}{tfb2}{tfb3}{0cm}{0cm}{1cm}
18 \kLinkHVHLeft[0.8cm]{$y$}{tfb3}{tfb2}{0cm}{-0.2cm}
19 \end{kblock}

```

## F. Ex:F

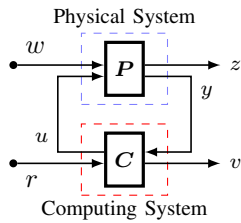


```

1 \begin{kblock}
2 % generic coordinate reference points
3 %\kJumpCS[0,0]{}
4 \kJumpCS{i}
5 \kJumpCSRRight[-0.5cm]{i}{iR}{0cm}{3}
6 \kJumpCSLeft[-0.5cm]{i}{iL}{0cm}{9}
7 \kJumpCSAbove[-0.5cm]{i}{iA}{0cm}{12}
8 \kJumpCSBelow[-0.5cm]{i}{iB}{0cm}{6}
9
10 % blks
11 \kTFBelow[{}]{iB}{tfb1}{\kMT{\mathcal{K}}(\cdot)}
12 \kTFBelow[{}]{tfb1}{tfb2}{\kMT{\mathcal{P}}(s)}
13
14 % links
15 \kInLeftM[0cm]{tfb1}{inR}{$r$}{0.05cm}{6}
16 \kMarkNodeLeft[0cm]{0cm}{tfb2}{ny}
17 \kOutLeft[-0.5cm]{ny}{outY}{$y$}{0cm}
18 \kLink[{}]{ny}{tfb2}
19 \kLinkVH[$y$]{ny}{tfb1}{-0.1cm}{0cm}{2}{}
20 \kLinkHVHRight[0.6cm]{$u$}{tfb1}{tfb2}{0cm}{0cm}
21
22 % covers
23 \kCoverRect[magenta!5!red]{tfb2}
24 {0.1cm}{0.1cm}{0.3cm}{0.3cm}
25 \kCoverTextBelow[0cm]{0cm}{txt1}
26 {physical system (e.g: a dc motor)};
27 %
28 \kCoverRect[green!75!blue!80!]{tfb1}
29 {0.1cm}{0.1cm}{0.2cm}{0.2cm}
30 \kCoverTextAbove[0cm]{0cm}{txt2}
31 {computing system (embedded control algorithm)};
32 \end{kblock}

```

## G. Ex:G

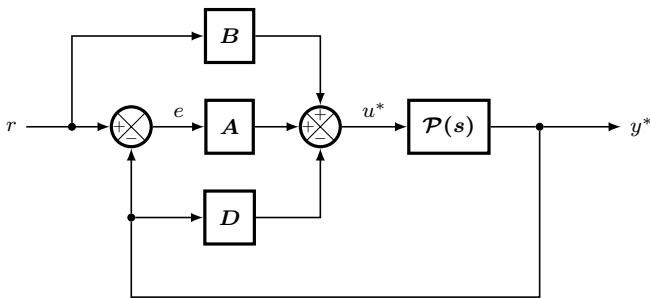


```

1 \centering
2
3 \begin{kblock}
4 \kJumpCS{R}
5
6 % blks
7 \kTFRight[R]{tfb1}{\bm{P}}
8 \kTFBelow{tfb1}{tfb2}{\bm{C}}
9
10 % links
11 \kInLeftM[0cm]{tfb1}{inW}{\$w\$}{0.05cm}{2}
12 \kInLeftM[0cm]{tfb2}{inR}{\$r\$}{-0.05cm}{5}
13 \kOutRight[0cm]{tfb1}{outZ}{\$z\$}{0.05cm}
14 \kOutRight[0cm]{tfb2}{outV}{\$v\$}{-0.05cm}
15 \kLinkHVHRight[0.6cm]{\$y\$}{tfb1}{tfb2}{-0.1cm}{0.1cm}
16 \kLinkHVHLeft[0.6cm]{\$u\$}{tfb2}{tfb1}{0.1cm}{-0.1cm}
17
18 % covers
19 \kCoverRect[blue!50!]{tfb1}
20 {0.1cm}{0.1cm}{0.3cm}{0.3cm}
21 \kCoverTextAbove{0cm}{0cm}{txt1}{Physical System};
22 %
23 \kCoverRect[red]{tfb2}
24 {0.1cm}{0.1cm}{0.3cm}{0.3cm}
25 \kCoverTextBelow{0cm}{0cm}{txt2}{Computing System};
26 \end{kblock}

```

## H. Ex:H

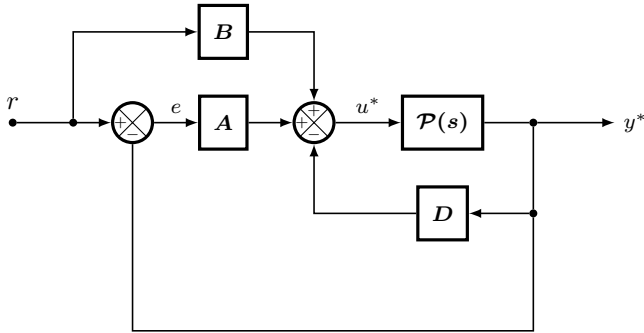


```

1 % Description: Closed PID-loop
2 \centering
3 \begin{kblock}
4 % global ref point
5 \kJumpCS{SRef}
6
7 %% blocks
8 \kTFAbove[5cm]{SRef}{tFD}{\kmT{D}}
9 \kMarkNodeLeft{0.1cm}{0cm}{tFD}{yin}
10 \kPlusMinusDownPlaceAbove{yin}{S1}{0cm}
11 \kTFAbove[]tFDtFA{\kmT{A}}
12 \kTFAbove[]tFAtFB{\kmT{B}}
13 \kPlusPlusMinus{tFA}{S2}{0cm}
14 \kTFRight[0.5cm]{S2}{tFP}{\kmT{\mathcal{P}(s)}}
15
16 %% other nodes-paths
17 \kMarkNodeRight{0cm}{0cm}{tFP}{ycut}
18 \kInLeft[0.1cm]{S1}{rin}{\$r\$}{0cm}
19 \kOutRight[0.1cm]{ycut}{yout}{\$y^*\$}{0cm}
20 \kMarkNodeRight{-0.4cm}{0cm}{rin}{rcut}
21
22 %% links
23 \kLink[\$e\$]{S1}{tFA}
24 \kLinkVH[]rcut}{tFB}{0cm}{0cm}{0}{}
25 \kLink[]tFA}{S2}
26 \kLinkHV[]tFB}{S2}{0cm}{0cm}{0}{}
27 \kLink[\$u^*\$]{S2}{tFP}
28 \kLinkHV[]tFD}{S2}{0cm}{0cm}{0}{}
29 \kLinkn[]tFP}{ycut}
30 \kLinknVHHVBelow[1.2cm]{ycut}{yin}{0cm}{0cm}
31 \kLink[]yin}{tFD}
32 \kLink[]yin}{S1}
33 \end{kblock}

```

## I. Ex:I

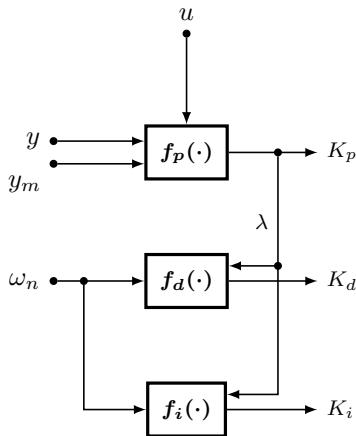


```

1 % Description: Closed PID-loop
2 \centering
3 \begin{kblock}
4 % global ref point
5 \kJumpCS{SRef}
6
7 %% blocks
8
9 \kTFAbove[{}]{SRef}{tFA}{\kmT{A}}
10 \kPlusMinusDownL{tFA}{S1}{0cm}
11 \kTFAbove[{}]{tFA}{tFB}{\kmT{B}}
12 \kPlusPlusMinus{tFA}{S2}{0cm}
13 \kTFRight[0.5cm]{S2}{tFP}{\kmT{\mathcal{P}(s)}}
14 \kTFBelow[0cm]{tFP}{tFD}{\kmT{D}}
15 \kMarkNodeRight[0cm]{0cm}{tFP}{yout}
16 \kMarkNodeBelow[0cm]{0cm}{yout}{yin}
17 \kInLeftM[0.1cm]{S1}{rin}{r$}{0cm}{0}
18 \kOutRight[0.1cm]{yout}{yout}{y^*}$}{0cm}
19 \kMarkNodeRight[-0.4cm]{0cm}{rin}{rcut}
20
21 %% links
22 \kLink[$e$]{S1}{tFA}
23 \kLinkVH[{}]{rcut}{tFB}{0cm}{0cm}{0}{0}
24 \kLink[{}]{tFA}{S2}
25 \kLinkHV[{}]{tFB}{S2}{0cm}{0cm}{0}{0}
26 \kLink[$u^*$]{S2}{tFP}
27 \kLinkHV[{}]{tFD}{S2}{0cm}{0cm}{0}{0}
28 \kLinkn[{}]{tFP}{yout}
29 \kLinkn[{}]{yout}{yin}
30 \kLinknVHHVBelow[0.5cm]{yin}{S1}{0cm}{0cm}
31 \kLink[{}]{yin}{tFD}
32 \end{kblock}

```

## J. Ex:J

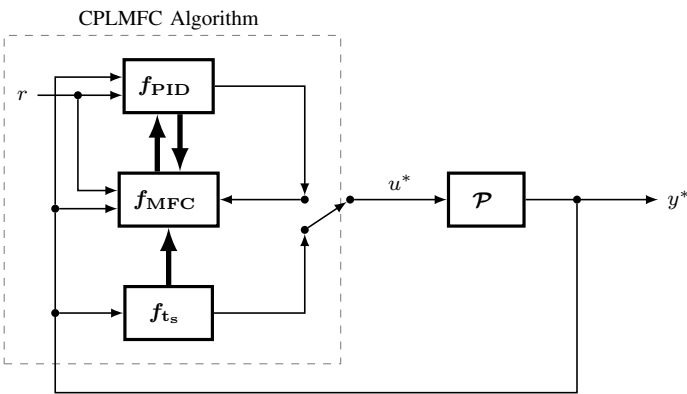


```

1 % Description: Anon
2 \centering
3 \begin{kblock}
4 % global ref point
5 \kJumpCS{o}
6
7 %% blocks
8 \kTFAbove[0cm]{o}{tfi}{\kmT{f_i(\cdot)}}
9 \kTFAbove[0.5cm]{tfi}{tfd}{\kmT{f_d(\cdot)}}
10 \kTFAbove[0.5cm]{tfd}{tfp}{\kmT{f_p(\cdot)}}
11
12 %% links
13 \kInUpM[0cm]{tfp}{inu}{u$}{0cm}{0}
14 \kOutRight[0.3cm]{tfp}{kp}{K_p$}{0cm}
15 \kOutRight[0.3cm]{tfi}{ki}{K_i$}{0cm}
16 \kOutRight[0.3cm]{tfd}{kd}{K_d$}{0cm}
17 \kInLeftM[0cm]{tfd}{inwn}{\omega_n$}{0cm}{6}
18 \kInLeftM[0cm]{tfp}{iny}{y$}{0.15cm}{6}
19 \kInLeftM[0cm]{tfp}{iny}{y_m$}{-0.15cm}{4}
20 \kMarkNodeLeft[-0.35cm]{0cm}{kp}{kpcut}
21 \kLinkVH[\lambda]{kpcut}{tfd}{0.2cm}{0cm}{2}{kpcutb}
22 \kLinkVH[{}]{kpcutb}{tfi}{0.2cm}{0cm}{0}{0}
23 \kMarkNodeRight[-0.8cm]{0cm}{inwn}{wncut}
24 \kLinkVH[{}]{wncut}{tfi}{0cm}{0cm}{0}{0}
25 \end{kblock}

```

## K. Ex:K

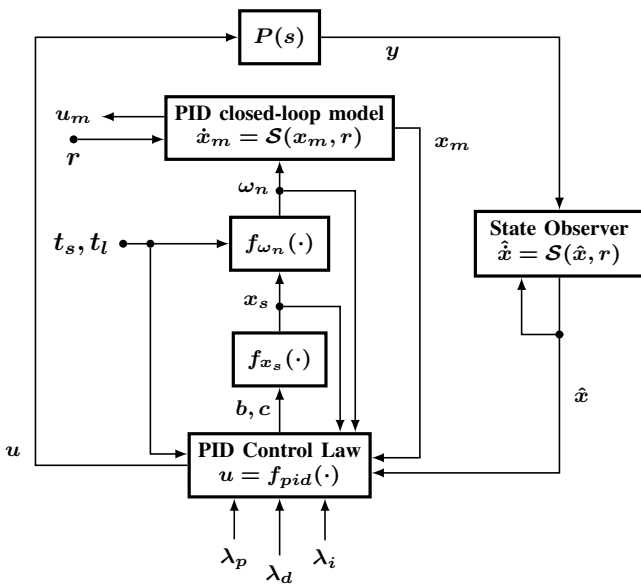


```

1 % DESCRIPTION: CPLMFC-Algorithm
2 \begin{kblock}
3 % global ref point
4 \kJumpCS{SRef}
5 %% blocks
6 % place TF_fts right of global ref.
7 \kTFRight[4cm]{SRef}{TF_fts}{ \kmtw{f_{\mathrm{t_s}}} }
8 % place TF_mfc at h cm above TF_fts
9 \kTFAbove[0.3cm]{TF_fts}{TF_mfc}{ \kmt{f_{\mathrm{MFC}}} }
10 \kTFAbove[0.3cm]{TF_mfc}{TF_pid}{ \kmt{f_{\mathrm{PID}}} }
11 \kTFRight[3cm]{TF_mfc}{TF_sys}{ \kmtw{ \mathcal{P} } }
12
13 %% nodes and links
14 % mark visible node N1 right of TF_mfc
15 \kMarkNodeRight{0.6cm}{0cm}{TF_mfc}{N1}
16 \kMarkNodeBelow{-0.8cm}{0cm}{N1}{N2}
17 \kMarkNodeRight{-0.6cm}{0cm}{N1}{N3}
18 \kMarkNodeRight{0cm}{0cm}{TF_sys}{N4}
19 % extend node-path outwards
20 \kOutRight[0.1cm]{N4}{Y1}{\mathit{y}^*}{0cm}
21 \kMarkNodeLeft{0.3cm}{0cm}{TF_fts}{N5}
22 \kMarkNodeLeft{0.3cm}{-0.12cm}{TF_mfc}{N6}
23 \kInLeft[0.12cm]{TF_pid}{R1}{\mathit{r}}{-0.12cm}
24 \kMarkNodeLeft{0cm}{-0.12cm}{TF_pid}{N7}
25 % link TF_sys to N4
26 \kLinkn[TF_sys]{N4}
27 \kLink[\mathit{y}^*]{N3}{TF_sys}
28 \kLink[N1]{TF_mfc}
29 \kLinkHV[TF_fts]{N2}{0cm}{0cm}{0}{}
30 % HV link from TF_pid to N1
31 \kLinkHV[{\$(TF_pid.east) + (0,0cm)\$}{N1}{0cm}{0cm}{0}{}
32 \kLinkHV[TF_pid]{N1}{0cm}{0cm}{0}{}
33 % link N1 to N3
34 \kLink[N1]{N3}
35 % link N2 to N3
36 \kLink[N2]{N3}
37 % VHV feedback link from N4 to N5
38 \kLinknVHHVBelow[1.5cm]{N4}{N5}{0cm}{0cm}
39 \kLink[N5]{TF_fts}
40 \kLink[N6]{\$(TF_mfc.west) + (0,-0.12cm)\$}
41 % arrowless link N5 and N6
42 \kLinkn[N5]{N6}
43 \kLinkVH[N6]{TF_pid}{0.12cm}{0cm}{0}{}
44 \kLinkVH[N7]{TF_mfc}{0.12cm}{0cm}{0}{}
45 %% vector links
46 % link from inside TF_fts to TF_mfc
47 \kVecLink[\mathit{f}]{TF_fts}{TF_mfc}
48 % link from inside TF_mfc to TF_pid
49 \kVecLink[\mathit{f}]{TF_mfc}{TF_pid}
50 \kVecLink[\mathit{f}]{\$(TF_mfc.north) + (-0.15cm,0cm)\$}
51 {\$(TF_pid.south) + (-0.15cm,0cm)\$}
52 % link from inside TF_pid to TF_mfc
53 \kVecLink[\mathit{f}]{\$(TF_pid.south) + (0.15cm,0cm)\$}
54 {\$(TF_mfc.north) + (0.15cm,0cm)\$}
55
56 %% cover-sectioning
57 \kCoverRect[gray]{TF_mfc}
58 {1.8cm}{1.8cm}{1.5cm}{1.6cm}
59 \kCoverTextAbove{0cm}{0cm}{CT1}{CPLMFC Algorithm};%
60
61 \end{kblock}

```

L. Ex:L



```

1 \begin{kblock}
2 \kJumpCS{fspt}
3
4 % blks
5 \kTFBelow[0.5cm]{fspt}{plt}{\kMT{P(s)}}
6 \kTFBelow[0cm]{plt}{pidcm}{
7 \textbf{PID closed-loop model}}\
8 $
9 \begin{array}{c}
10 \bm{\dot{x}}_m=\mathcal{S}(x_m, r)
11 \end{array}
12 $
13 }
14 \kTFBelow[0.33cm]{pidcm}{tscal}
15 {\kMT{f_{\omega_n}(\cdot)}}
16 \kTFBelow[0.33cm]{tscal}{fis}{\kMT{f_{x_s}(\cdot)}}
17 \kTFBelow[0.2cm]{fis}{pid}{
18 \textbf{PID Control Law}}\
19 \kMT{u = f_{pid}(\cdot)}
20 }
21 \kTFRight[2.5cm]{tscal}{obs}{
22 \textbf{State Observer}}\
23 $
24 \begin{array}{c}
25 \hat{x}=\mathcal{S}(\hat{x}, r)
26 \end{array}
27 $
28 }
29
30 % links
31 \kInDown[-0.4cm]{pid}{cp}{\kMT{\lambda_p}}{-0.6cm}
32 \kInDown[-0.4cm]{pid}{ci}{\kMT{\lambda_i}}{0.6cm}
33 \kInDown[-0.2cm]{pid}{cd}{\kMT{\lambda_d}}{0cm}
34 \kLinkHVHLeft[2cm]{\kMT{u}}{pid}{plt}{0cm}{0cm}{}
35 \kLinkHV[\kMT{y}]{plt}{obs}{0cm}{0cm}{1}{}
36 \kLinkVH[\kMT{\hat{x}}]{obs}{pid}{-0.1cm}{0cm}{3}{}
37 \kLinkHVHRight[\kMT{x}_m]{pidcm}{pid}{0cm}{0.1cm}
38 \kLink[$\bm{\omega_n}$]{tscal}{pidcm}
39 \kLink[$\bm{x}_s$]{fis}{tscal}
40 \kLink[$\bm{b, c}$]{pid}{fis}
41 \kMarkNodeAbove{-0.5cm}{0cm}{}{tscal}{mkwn}
42 \kLinkHV[{}]{mkwn}{pid}{0cm}{1cm}{0cm}{}
43 \kMarkNodeAbove{-0.5cm}{0cm}{}{fis}{mkxts}
44 \kLinkHV[{}]{mkxts}{pid}{0cm}{0.8cm}{0}{}
45 \kInLeftM[0cm]{pidcm}{rin}{$\bm{r}$}{-0.15cm}{3}
46 \kOutLeft[0cm]{pidcm}{umout}{$\bm{u}_m$}{0.15cm}
47 \kInLeftM[0.2cm]{tscal}{tsl}{$\bm{t_s, t_l}$}{0cm}{6}
48 \kMarkNodeRight{-0.84cm}{0cm}{}{tsl}{mktsl}
49 \kLinkVH[{}]{mktsl}{pid}{0.15cm}{0cm}{0}{}
50 \kMarkNodeBelow[0cm]{0cm}{}{obs}{mkxhat}
51 \kLinkHV[{}]{mkxhat}{obs}{0cm}{-0.5cm}{0}{}
52 \end{kblock}

```



### III. *k*BLOCKS API

**TODO ...**