

# *Circus*-L<sup>A</sup>T<sub>E</sub>X style explained Community Z Tools (CZT)

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\* PARSER DOES NOT YET SUPPORT LOGICAL CONSTANTS

## A Reference card

### A.1 Special *Circus* symbols

#### Refinement

$n \Vdash S = I$	$n \text{ \texttt{\textbackslash circassertref } } S = I$
$n \Vdash S \preceq I$	$n \text{ \texttt{\textbackslash circassertref } } S \text{ \texttt{\textbackslash circsimulates } } I$
$n \Vdash S \sqsubseteq I$	$n \text{ \texttt{\textbackslash circassertref } } S \text{ \texttt{\textbackslash circrefines } } I$
$n \Vdash S \sqsubseteq Tr\ I$	$n \text{ \texttt{\textbackslash circassertref } } S \text{ \texttt{\textbackslash circrefines } } Tr\ I$
$n \Vdash S \sqsubseteq SFl\ I$	$n \text{ \texttt{\textbackslash circassertref } } S \text{ \texttt{\textbackslash circrefines } } SFl\ I$
$n \Vdash S \sqsubseteq FLDv\ I$	$n \text{ \texttt{\textbackslash circassertref } } S \text{ \texttt{\textbackslash circrefines } } FLDv\ I$

### A.2 *Circus* channels and name sets

<u><i>channel</i></u> $e$	$\text{\texttt{\textbackslash circchannel } } e$
<u><i>channel</i></u> $c : T$	$\text{\texttt{\textbackslash circchannel } } c : T$
<u><i>channel</i></u> $[X]c : X$	$\text{\texttt{\textbackslash circchannel } } [X] c : X$
<u><i>channelfrom</i></u> $S$	$\text{\texttt{\textbackslash circchannelfrom } } S$
<u><i>channelfrom</i></u> $[X]S[X]$	$\text{\texttt{\textbackslash circchannelfrom } } [X] S[X]$
<u><i>channelset</i></u> $n == \{ c \}$	$\text{\texttt{\textbackslash circchannelset } } n == \text{\texttt{\textbackslash lchanset } } c \text{ \texttt{\textbackslash rchanset } }$
<u><i>channelset</i></u> $n == CSRef$	$\text{\texttt{\textbackslash circchannelset } } n == CS$
<u><i>channelset</i></u> $[X]n == CSRef$	$\text{\texttt{\textbackslash circchannelset } } [X] n == CS$
<u><i>nameset</i></u> $n == \{ x \}$	$\text{\texttt{\textbackslash circnameset } } n == \{ \sim x \sim \}$
<u><i>nameset</i></u> $n == NSRef$	$\text{\texttt{\textbackslash circnameset } } n == NS$

### A.3 *Circus* actions

#### Action definition

$n \hat{=} A$	$n \text{ \texttt{\textbackslash circdef } } A$
$n \hat{=} x : T \bullet A$	$n \text{ \texttt{\textbackslash circdef } } x : T \text{ \texttt{\textbackslash circspot } } A$

#### Basic actions

<u><i>Skip</i></u>	$\text{\texttt{\textbackslash Skip}}$
<u><i>Stop</i></u>	$\text{\texttt{\textbackslash Stop}}$
<u><i>Chaos</i></u>	$\text{\texttt{\textbackslash Chaos}}$

#### Prefixing action

$e \longrightarrow A$	$e \text{ \texttt{\textbackslash then } } A$
$c.0 \longrightarrow A$	$c.0 \text{ \texttt{\textbackslash then } } A$
$c!v \longrightarrow A$	$c!v \text{ \texttt{\textbackslash then } } A$
$c?x \longrightarrow A$	$c?x \text{ \texttt{\textbackslash then } } A$
$c?x!y?z \longrightarrow A$	$c?x!y?z \text{ \texttt{\textbackslash then } } A$

### Prefixing action (extra)

$c?x : (P)!(f\ x) \longrightarrow A$   
 $c?x \ \backslash\text{prefixcolon} \ (P)!(f\sim x) \ \backslash\text{then} \ A$   
 $c?x : (x > 1)!(f\ x) \longrightarrow A$   
 $c?x \ \backslash\text{prefixcolon} \ (x > 1)!(f\sim x) \ \backslash\text{then} \ A$   
 $c[\mathbb{N} \times \mathbb{P} \mathbb{N}]?x!(\text{dom } R) \longrightarrow A$   
 $c[\backslash\text{nat} \ \backslash\text{cross} \ \backslash\text{power}\sim\backslash\text{nat}]?x!(\backslash\text{dom}\sim R) \ \backslash\text{then} \ A$

### Unary actions

$(S)$   $\backslash\text{lschexpract } S \ \backslash\text{rschexpract}$   
 $\mu X \bullet A$   $\backslash\text{circmu } X \ \backslash\text{circspot } A$   
 $A \setminus CS$   $A \ \backslash\text{circhide } CS$   
 $(P) \& A$   $\backslash\text{lcircguard } P \ \backslash\text{rcircguard } \backslash\text{circguard } A$

### Binary actions

$A \parallel NSa \mid NSb \parallel B$   $A \ \backslash\text{linter } NSa \mid NSb \ \backslash\text{rinter } B$   
 $A \parallel B$   $A \ \backslash\text{interleave } B$   
 $A \parallel NSa \mid CS \mid NSb \parallel B$   $A \ \backslash\text{lpar } NSa \mid CS \mid NSb \ \backslash\text{rpar } B$   
 $A \parallel CS \parallel B$   $A \ \backslash\text{lpar } CS \ \backslash\text{rpar } B$   
 $A[NSb \mid CSa \mid CSb \mid NSb]B$   $A \ [ \ NSb \mid CSa \mid CSb \mid NSb \ ] \ B$   
 $A[CSa \mid CSb]B$   $A \ [ \ CSa \mid CSb \ ] \ B$   
 $A \sqcap B$   $A \ \backslash\text{intchoice } B$   
 $A \square B$   $A \ \backslash\text{extchoice } B$   
 $A ; B$   $A \ \backslash\text{circseq } B$   
 $AName$   $AName$   
 $AName(x, y)$   $AName(x, y)$   
 $AName[new/old, x/y]$   $AName[new/old, x/y]$

### Replicated actions

$\parallel x : T \bullet A$   $\backslash\text{Interleave } x : T \ \backslash\text{circspot } A$   
 $\parallel x : T \parallel NS \bullet A$   $\backslash\text{Interleave } x : T \ \backslash\text{linter } NS \ \backslash\text{rinter } \backslash\text{circspot } A$   
 $\parallel CS \parallel x : T \bullet NS \parallel A$   $\backslash\text{lpar } CS \ \backslash\text{rpar } x : T \ \backslash\text{circspot } \backslash\text{lpar } NS \ \backslash\text{rpar } A$   
 $\parallel CS \parallel x : T \bullet A$   $\backslash\text{lpar } CS \ \backslash\text{rpar } x : T \ \backslash\text{circspot } A$   
 $\sqcap x : T \bullet A$   $\backslash\text{Intchoice } x : T \ \backslash\text{circspot } A$

$\Box x : T \bullet A$	<code>\Extchoice x : T \circspot A</code>
$\dot{;} x : T \bullet A$	<code>\Semi x : T \circspot A</code>

#### Parentthesised actions

$(A)$	<code>(A)</code>
$(x : T \bullet A)$	<code>(x : T \circspot A)</code>
$(\underline{\mathbf{val}} x : T \bullet A)$	<code>(\circval x : T \circspot A)</code>
$(\underline{\mathbf{res}} x : T \bullet A)$	<code>(\circres x : T \circspot A)</code>
$(\underline{\mathbf{vres}} x : T \bullet A)$	<code>(\circvres x : T \circspot A)</code>
$(x : T \bullet A)(v)$	<code>(x : T \circspot A)(v)</code>
$(\underline{\mathbf{val}} x : T \bullet A)(v)$	<code>(\circval x : T \circspot A)(v)</code>
$(\underline{\mathbf{res}} x : T \bullet A)(v)$	<code>(\circres x : T \circspot A)(v)</code>
$(\underline{\mathbf{vres}} x : T \bullet A)(v)$	<code>(\circvres x : T \circspot A)(v)</code>
$(\mu X \bullet x : T \bullet A)(v)$	<code>(\circmu X \circspot x : T \circspot A)(v)</code>
$(\mu X \bullet (x : T \bullet A))(v)$	<code>(\circmu X \circspot (x : T \circspot A))(v)</code>
$(\mu X \bullet \underline{\mathbf{val}} x : T \bullet A)(v)$	<code>(\circmu X \circspot \circval x : T \circspot A)(v)</code>
$(\mu X \bullet \underline{\mathbf{res}} x : T \bullet A)(v)$	<code>(\circmu X \circspot \circres x : T \circspot A)(v)</code>
$(\mu X \bullet \underline{\mathbf{vres}} x : T \bullet A)(v)$	<code>(\circmu X \circspot \circvres x : T \circspot A)(v)</code>

### A.4 Circus command definitions

#### Guarded commands

$x, y := v1, v2$	<code>x, y := v1, v2</code>
$x, y : [P, Q]$	<code>x, y \prefixcolon [~ P, Q ~]</code>
$: [P, Q]$	<code>\prefixcolon [~ P, Q ~]</code>
$\{P\}$	<code>\{~ P ~\}</code>
$[P]$	<code>[~ P ~]</code>
$\underline{\mathbf{if}} P \longrightarrow A \parallel B \underline{\mathbf{fi}}$	<code>\circif P \circrthen A \circrclse B \circrffi</code>
$\underline{\mathbf{do}} P \longrightarrow A \underline{\mathbf{od}}$	<code>\circdo P \circrthen A \circrcod</code>
$\underline{\mathbf{con}} X \bullet A$	<code>\circcon X \circspot A</code>
$\underline{\mathbf{var}} x : T \bullet A$	<code>\circvar x : T \circspot A</code>

#### Parameterised commands

$\underline{\mathbf{val}} x : T \bullet A$	<code>\circval x : T \circspot A</code>
$\underline{\mathbf{res}} x : T \bullet A$	<code>\circres x : T \circspot A</code>

$\underline{vres} x : T \bullet A$        $\backslash\text{circvres } x : T \backslash\text{circspot } A$

## A.5 Circus processes

### Process definition

$\underline{process} n \hat{=} PD$        $\backslash\text{circprocess } n \backslash\text{circdef } PD$   
 $\underline{process}[X]n \hat{=} PD$        $\backslash\text{circprocess } [X] n \backslash\text{circdef } PD$

### Basic process

$\underline{process} n \hat{=} \underline{begin} \dots BP \dots \underline{end}$   
 $\backslash\text{circprocess } n \backslash\text{circdef } \backslash\text{circbegin } \ldots BP \ldots \backslash\text{circend}$   
 $\underline{state} n == S$        $\backslash\text{circstate } n == S$   
 $\underline{state} S$        $\backslash\text{circstate } S$

### Unary processes

$P \setminus CS$        $P \backslash\text{circhide } CS$   
 $PName$        $PName$   
 $PName[\mathbb{N}]$        $PName[\backslash\text{nat}]$   
 $PName(x, y)$        $PName(x, y)$   
 $PName[\mathbb{N}](x, y)$        $PName[\backslash\text{nat}](x, y)$   
 $PName[x]$        $PName \backslash\text{lcircindex } x \backslash\text{rcircindex}$   
 $PName[\mathbb{N}][x]$        $PName[\backslash\text{nat}] \backslash\text{lcircindex } x \backslash\text{rcircindex}$   
 $PName[c, d := e, f]$        $PName \backslash\text{lcircrename } c, d := e, f \backslash\text{rcircrename}$   
 $PName[\mathbb{N}][c, d := e, f]$        $PName[\backslash\text{nat}] \backslash\text{lcircrename } c, d := e, f \backslash\text{rcircrename}$

### Binary processes

$P \parallel Q$        $P \backslash\text{interleave } Q$   
 $P \llbracket CS \rrbracket Q$        $P \backslash\text{lpar } CS \backslash\text{rpar } Q$   
 $P \sqcap Q$        $P \backslash\text{intchoice } Q$   
 $P \sqcup Q$        $P \backslash\text{extchoice } Q$   
 $P ; Q$        $P \backslash\text{circseq } Q$

### Parameterised and indexed processes

$x : T \bullet P$        $x : T \backslash\text{circspot } P$   
 $x : T \odot P$        $x : T \backslash\text{circindex } P$

### Parenthesised processes

$(P)$	$(P)$
$(x : T \bullet P)$	$(x : T \backslash \text{circspot } P)$
$(x : T \odot P)$	$(x : T \backslash \text{circindex } P)$
$(P)[c := d]$	$(P) \backslash \text{lcircrename } c := d \backslash \text{rcircrename}$
$(x : T \bullet P)[c := d]$	$(x : T \backslash \text{circspot } P) \backslash \text{lcircrename } c := d \backslash \text{rcircrename}$
$(x : T \odot P)[c := d]$	$(x : T \backslash \text{circindex } P) \backslash \text{lcircrename } c := d \backslash \text{rcircrename}$
$(x : T \bullet P)(v)$	$(x : T \backslash \text{circspot } P)(v)$
$(x : T \odot P)(v)$	$(x : T \backslash \text{circindex } P)(v)$
$[X](x : X \bullet P)[\mathbb{N}](1)$	$[X](x : X \backslash \text{circspot } P)[\backslash \text{nat}](1)$
$[X](x : X \odot P)[\mathbb{N}](1)$	$[X](x : X \backslash \text{circindex } P)[\backslash \text{nat}](1)$
$(\mu X \bullet x : T \bullet P)(v)$	$(\backslash \text{circmu } X \backslash \text{circspot } x : T \backslash \text{circspot } P)(v)$
$(\mu X \bullet (x : T \bullet P))(v)$	$(\backslash \text{circmu } X \backslash \text{circspot } (x : T \backslash \text{circspot } P))(v)$
$(\mu X \bullet \underline{\text{val}} x : T \bullet P)(v)$	$(\backslash \text{circmu } X \backslash \text{circspot } \backslash \text{circval } x : T \backslash \text{circspot } P)(v)$

### Replicated processes

$\  x : T \bullet P$	$\backslash \text{Interleave } x : T \backslash \text{circspot } P$
$\  x : T \llbracket CS \rrbracket \bullet P$	$\backslash \text{Parallel } x : T \backslash \text{lpar } CS \backslash \text{rpar } \backslash \text{circspot } P$
$\sqcap x : T \bullet P$	$\backslash \text{Intchoice } x : T \backslash \text{circspot } P$
$\square x : T \bullet P$	$\backslash \text{Extchoice } x : T \backslash \text{circspot } P$
$; x : T \bullet P$	$\backslash \text{Semi } x : T \backslash \text{circspot } P$

## A.6 Mathematical toolkits $SS \diamond S$ $SS \backslash \text{dcap } S$

### Circus prelude

$\mathbb{B}$	$\backslash \text{boolean}$
$\mathbb{U}$	$\backslash \text{universe}$
$\underline{\text{True}}$	$\backslash \text{true}$
$\underline{\text{False}}$	$\backslash \text{false}$

### Circus model checking toolkit

$SS \bowtie TT$	$SS \backslash \text{gendj } TT$
$\otimes SS$	$\backslash \text{regions } SS$
$SS \searrow S$	$SS \backslash \text{dsetminus } S$

### Circus Spivey's Z bag toolkit

$\text{bag } X$	$\backslash \text{bag} \sim X$
$B \# n$	$B \backslash \text{bcount } n$
$n \otimes B$	$n \backslash \text{otimes } B$
$B \uplus C$	$B \backslash \text{uplus } C$
$B \uplus C$	$B \backslash \text{uminus } C$
$x \in B$	$x \backslash \text{inbag } B$
$B \sqsubseteq C$	$B \backslash \text{subbageq } C$
$\llbracket x, y \rrbracket$	$\backslash \text{lbag } x, y \backslash \text{rbag}$

## References