$ \begin{split} & \text{let } (\text{ref high } ((\$ \text{ true})_{\text{low}})) \{ (\text{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^{1} (\text{Ref Bool}_{\star})_{\star} \} \text{ in } \\ & \text{let if } ((\$ \text{ true})_{\text{high}}) ((\ \ \ \ \ \)) =^{?} (((\$ \text{ false})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{3} \text{Bool}_{\star} \})) ((\ \ \ \ \ \ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \})) \text{ in } \\ & (\ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \}) \text{ in } \\ & (\ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \}) \text{ in } \\ & (\ \ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \}) \text{ in } \\ & (\ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \}) \text{ in } \\ & (\ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \}) \text{ in } \\ & (\ \ \ \)) =^{?} (((\$ \text{ true})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \}) \text{ in } \\ & (\ \ \ \)) =^{?} ((\S \text{ true})_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \Rightarrow^{4} \text{Bool}_{\star} \}) \text{ in } \\ & (\ \ \ \)) =^{?} ((\S \text{ true})_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \Rightarrow^{4}$	$let (ref \ high ((\$ \ true)_{low})) \{ (Ref \ Bool_{high})_{low} \Rightarrow^{1} (Ref \ Bool_{high})_{*} \} \ in$ $let \ if ((\$ \ true)_{high}) (((\char) \{ (Ref \ Bool_{high})_{*} \Rightarrow^{3} (Ref \ Bool_{high})_{high} \}) := ((\$ \ false)_{low})) (((\char) \{ (Ref \ Bool_{high})_{*} \Rightarrow^{4} (Ref \ Bool_{high})_{high} \}) := ((\$ \ true)_{low})) \ in$ $! (\char) 1)$
$\xi(\xi(\mathit{ref-static}))$	$\xi(\xi(\textit{ref-static}))$
$ \left(\operatorname{ref}^{\checkmark} \operatorname{high} \left((\$ \operatorname{true})_{\operatorname{low}} \right) \right) \left\{ (\operatorname{Ref} \operatorname{Bool}_{\operatorname{high}})_{\operatorname{low}} \Rightarrow^{1} \left(\operatorname{Ref} \operatorname{Bool}_{\star} \right)_{\star} \right\} \operatorname{in} $ $ \left((\$ \operatorname{true})_{\operatorname{high}} \right) \left((\ 0) :=^{?} \left(((\$ \operatorname{false})_{\operatorname{low}}) \left\{ \operatorname{Bool}_{\operatorname{low}} \Rightarrow^{3} \operatorname{Bool}_{\star} \right\} \right) \right) \left((\ 0) :=^{?} \left(((\$ \operatorname{true})_{\operatorname{low}}) \left\{ \operatorname{Bool}_{\operatorname{low}} \Rightarrow^{4} \operatorname{Bool}_{\star} \right\} \right) \right) \operatorname{in} $	$ \text{let } (\text{ref}^{\checkmark} \text{ high } ((\$ \text{ true})_{\text{low}})) \{ (\text{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^{1} (\text{Ref Bool}_{\text{high}})_{\star} \} \text{ in } $ $ \text{let if } ((\$ \text{ true})_{\text{high}}) (((\char) \{ (\text{Ref Bool}_{\text{high}})_{\star} \Rightarrow^{3} (\text{Ref Bool}_{\text{high}})_{\text{high}} \}) := ((\$ \text{ false})_{\text{low}})) (((\char) ((\char) (\text{Ref Bool}_{\text{high}})_{\star} \Rightarrow^{4} (\text{Ref Bool}_{\text{high}})_{\text{high}} \}) := ((\$ \text{ true})_{\text{low}})) \text{ in } $
! (`1)	! (`1)
$\xi(\xi(ref))$	$\xi(\xi(ref))$
$ \begin{split} & \text{let } \left((\text{addr } 0_{\text{high}})_{\text{low}} \right) \left\{ \left(\text{Ref Bool}_{\text{high}} \right)_{\text{low}} \Rightarrow^{1} \left(\text{Ref Bool}_{\star} \right)_{\star} \right\} \text{ in } \\ & \text{let if } \left((\$ \text{ true})_{\text{high}} \right) \left((\char{^{\sim}} 0) := ? \left(\left((\$ \text{ false})_{\text{low}} \right) \left\{ \text{Bool}_{\text{low}} \Rightarrow^{3} \text{Bool}_{\star} \right\} \right) \right) \left((\char{^{\sim}} 0) := ? \left(\left((\$ \text{ true})_{\text{low}} \right) \left\{ \text{Bool}_{\text{low}} \Rightarrow^{4} \text{Bool}_{\star} \right\} \right) \right) \text{ in } \\ & \text{! } \left(\char{^{\sim}} 1 \right) \end{aligned} $	$let ((addr 0_{high})_{low}) \{ (Ref Bool_{high})_{low} \Rightarrow^{1} (Ref Bool_{high})_{\star} \} in$ $let if ((\$ true)_{high}) (((\^{0}) \{ (Ref Bool_{high})_{\star} \Rightarrow^{3} (Ref Bool_{high})_{high} \}) := ((\$ false)_{low})) (((\^{0}) \{ (Ref Bool_{high})_{\star} \Rightarrow^{4} (Ref Bool_{high})_{high} \}) := ((\$ true)_{low})) in$ $! (\^{1})$
$eta ext{-}let$	$eta ext{-let}$
$ \downarrow \\ \text{let if } ((\$ \text{ true})_{\text{high}}) \ ((((\text{addr } 0_{\text{high}})_{\text{low}}) \{ (\text{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^{1} (\text{Ref Bool}_{\star})_{\star} \}) := ? (((\$ \text{ false})_{\text{low}}) \{ (\text{Bool}_{\text{low}}) \} ((((\text{addr } 0_{\text{high}})_{\text{low}}) \} (((\text{addr } 0_{\text{high}})_{\text{low}})) (((\text{addr } 0_{\text{high}})_{\text{low}})) (((\text{addr } 0_{\text{high}})_{\text{low}})) (((\text{addr } 0_{\text{high}})_{low$	$! \text{ let if } ((\$ \text{ true})_{\text{high}}) (((((\texttt{addr } 0_{\text{high}})_{\text{low}}) \{ (\texttt{Ref Bool}_{\text{high}})_{\text{low}}) \} (\texttt{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^{1} (\texttt{Ref Bool}_{\text{high}})_{\text{low}}) \{ (\texttt{Ref Bool}_{\text{high}})_{\text{low}} \} (\texttt{Ref Bool}_{\text{high}})_{\text{low}}) \} (\texttt{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^{1} (\texttt{Ref Bool}_{\text{high}})_{\text{low}}) \} (\texttt{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^{1} (\texttt{Ref Bool}_{\text{high}})_{\text{low}}) \} (\texttt{Ref Bool}_{\text{low}})_{\text{low}}) $
$\xi(eta ext{-} ext{\it if-} ext{\it true})$	$\xi(eta ext{-}if ext{-}true)$
$\downarrow \\ \text{let prot high } \left(\left(\left(\left(\left(\text{addr } 0_{\text{high}} \right)_{\text{low}} \right) \left\{ \left(\text{Ref Bool}_{\text{high}} \right)_{\text{low}} \Rightarrow^{1} \left(\text{Ref Bool}_{\star} \right)_{\star} \right\} \right) :=^{?} \left(\left(\left(\text{$false$}_{\text{low}} \right) \left\{ \text{Bool}_{\text{low}} \Rightarrow^{3} \text{Bool}_{\star} \right\} \right) \right) \text{ in } \\ ! \left(\left(\left(\text{addr } 0_{\text{high}} \right)_{\text{low}} \right) \left\{ \left(\text{Ref Bool}_{\text{high}} \right)_{\text{low}} \Rightarrow^{1} \left(\text{Ref Bool}_{\star} \right)_{\star} \right\} \right)$	$\downarrow \\ \text{let prot } \underset{\text{high }}{\text{high }} \left(\left(\left(\left((\text{addr } 0_{\text{high}})_{\text{low}} \right) \right\} \left((\text{Ref Bool}_{\text{high}})_{\text{low}} \right) \right) \left((\text{Ref Bool}_{\text{high}})_{\star} \right) \right) \left((\text{Ref Bool}_{\text{high}})_{\star} \right) \right) \\ = \left(\left((\text{addr } 0_{\text{high}})_{\text{low}} \right) \left\{ (\text{Ref Bool}_{\text{high}})_{\text{low}} \right\} \right) \\ = \left((\text{addr } 0_{\text{high}})_{\text{low}} \right) \left\{ (\text{Ref Bool}_{\text{high}})_{\text{low}} \right\} \right)$
$\xi(\mathit{prot-ctx}(assign?-\mathit{cast}))$.	$\xi(prot\text{-}ctx(assign\text{-}static))$
$ \text{let prot high } (((\text{addr } 0_{\text{high}})_{\text{low}}) :=^? ((((\$ \text{ false})_{\text{low}}) \{ \text{Bool}_{\text{low}} \Rightarrow^3 \text{Bool}_{\star} \}) \{ \text{Bool}_{\star} \Rightarrow^1 \text{Bool}_{\text{high}} \})) \cdot \text{in}$ $! (((\text{addr } 0_{\text{high}})_{\text{low}}) \{ (\text{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^1 (\text{Ref Bool}_{\star})_{\star} \})$	$\frac{1}{2} \left($
$\xi(prot-ctx(assign?-ok))$	
$\underline{\text{let prot high }(((\text{addr }0_{\text{high}})_{\text{low}})):=^{\checkmark}(((((\text{false})_{\text{low}}) \{\text{Bool}_{\text{low}} \Rightarrow^3 \text{Bool}_{\star}\}) \{\text{Bool}_{\star} \Rightarrow^1 \text{Bool}_{\text{high}}\})) \text{ in }}$	let prot high $(((((addr 0_{high})_{low}) \{ (Ref Bool_{high})_{high} \Rightarrow^1 (Ref Bool_{high})_{high} \}) \{ (Ref Bool_{high})_{high} \Rightarrow^3 (Ref Bool_{high})_{high} \}) :=^{\checkmark} ((\$ false)_{low}))$ in
$ \frac{! \; (((\operatorname{addr} \; 0_{\operatorname{high}})_{\operatorname{low}}) \{ (\operatorname{Ref} \; \operatorname{Bool}_{\star})_{\star} \})}{\xi(\operatorname{prot-ctx}(\xi(\operatorname{cast})))} $	$! \left(\left(\left(\operatorname{addr} \left(0_{\operatorname{high}} \right)_{\operatorname{low}} \right) \left\{ \left(\operatorname{Ref} \left(\operatorname{Bool}_{\operatorname{high}} \right)_{\operatorname{low}} \right) \right\} \left(\operatorname{Ref} \left(\operatorname{Bool}_{\operatorname{high}} \right)_{\operatorname{high}} \right) \right\} \right) \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ \xi(\operatorname{prot-ctx}(\operatorname{assign-cast})) $
	$\{(\text{prot ems(acetyle ease}))\}$
	$! \; (((addr \; 0_{high})_{low}) \; \{ \; (Ref \; Bool_{high})_{low} \Rightarrow^1 \; (Ref \; Bool_{high})_{\star} \; \})$
$ \text{let prot high } (((\text{addr } 0_{\text{high}})_{\text{low}}) :=^{\checkmark} ((\$ \text{ false})_{\text{low}})) \text{ in } $ $! (((\text{addr } 0_{\text{high}})_{\text{low}}) \{ (\text{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^{1} (\text{Ref Bool}_{\star})_{\star} \}) $	$\xi(prot\text{-}ctx(\xi(cast)))$
	let prot high $((((addr 0_{high})_{low}) \{ (Ref Bool_{high})_{high} \Rightarrow^1 (Ref Bool_{high})_{high} \}) :=^{\checkmark} (((false)_{low})) in$ $! (((addr 0_{high})_{low}) \{ (Ref Bool_{high})_{low} \Rightarrow^1 (Ref Bool_{high})_{\star} \})$
	$\xi(\mathit{prot-ctx}(\mathit{assign-cast}))$
$\xi(prot\text{-}ctx(assign))$	$\vdots \\ \vdots \\$
	$\xi(\mathit{prot-ctx}(\xi(\mathit{cast})))$
	$\xi(prot\text{-}ctx(assign))$
$ \text{let prot } \underset{\text{high }((\$ \text{ unit})_{\text{low}}) \text{ in}}{\text{! }(((\text{addr } 0_{\text{high}})_{\text{low}}) \{ (\text{Ref Bool}_{\text{high}})_{\text{low}} \Rightarrow^{1} (\text{Ref Bool}_{\star})_{\star} \})}$	
$\xi(prot ext{-}val)$	$egin{array}{c} \xi(prot ext{-}val) \end{array}$
$\beta\text{-}let$	$\beta\text{-}let$
$! \; \left(\left((\operatorname{addr} 0_{\operatorname{high}})_{\operatorname{low}} \right) \{ (\operatorname{Ref} \operatorname{Bool}_{\operatorname{high}})_{\operatorname{low}} \Rightarrow^1 (\operatorname{Ref} \operatorname{Bool}_{\star})_{\star} \} \right) \qquad \cdots$	$! \; (((\texttt{addr} \; 0_{\texttt{high}})_{\texttt{low}}) \{ (\texttt{Ref Bool}_{\texttt{high}})_{\texttt{low}} \Rightarrow^1 (\texttt{Ref Bool}_{\texttt{high}})_\star \})$
deref-cast	deref-cast
$\left(! \left(\left(addr \ 0_{high} \right)_{low} \right) \right) \left\{ Bool_{high} \Rightarrow^{1} Bool_{\star} \right\}$	$ \big(! \; \big((addr \; 0_{high})_{low} \big) \big) \{ Bool_{high} \Rightarrow^1 Bool_{\star} \} $
$\xi(deref)$	$\xi(deref)$
$\left(\operatorname{prot} \underset{high}{high} \left(\left(\underset{false}{low} \right) \right) \left\{ \underset{Bool_{high}}{Bool_{high}} \Rightarrow^{1} \underset{Bool_{\star}}{Bool_{high}} \right\} \qquad \dots$	$ \left(\operatorname{prot} \operatorname{high} \left(\left(\$ \operatorname{false} \right)_{\operatorname{low}} \right) \right) \left\{ \operatorname{Bool}_{\operatorname{high}} \Rightarrow^{1} \operatorname{Bool}_{\star} \right\} $
$\xi(prot ext{-}val)$	$\xi(prot ext{-}val)$
$ \big((\$ false)_{high} \big) \{ Bool_{high} \Rightarrow^1 Bool_{\star} \} \qquad \cdots $	$ \qquad \qquad \qquad \qquad \big((\$\mathtt{false})_{\mathtt{high}}\big)\{\mathtt{Bool}_{\mathtt{high}}\Rightarrow^1\mathtt{Bool}_{\star}\} $