$$[CHAR]$$
$$STATE ::= READ \mid WRITE$$
$$RESPONSE ::= OK \mid FILE\_WRONG\_MODE$$

$$\begin{array}{|l} EOF : CHAR \end{array}$$

$$STRING == \mathrm{seq}\,(CHAR \setminus \{EOF\})$$

$$\begin{array}{|l} \multicolumn{1}{l}{\underline{\;File\;}} \\ content : STRING \\ state : STATE \\ position : \mathbb{N} \\ \hline \end{array}$$

$$WriteFail == [\Xi File;\ resp! : RESPONSE \setminus \{OK\} \mid state = READ \Rightarrow resp! = FILE\_WRONG\_MODE]$$
$$ReadFail == [\Xi File;\ resp! : RESPONSE \setminus \{OK\} \mid state = WRITE \Rightarrow resp! = FILE\_WRONG\_MODE]$$

$$\begin{array}{|l} \multicolumn{1}{l}{\underline{\;FileInit\;}} \\ File' \\ \hline content' = \langle\rangle \\ state' = WRITE \\ \hline \end{array}$$

$$\begin{array}{|l} \multicolumn{1}{l}{\underline{\;Overwrite\;}} \\ \Delta File \\ in? : STRING \\ \hline state = WRITE \\ content' = in? \\ state' = state \\ \hline \end{array}$$

Note ¨[Overwrite; resp!: {OK}]” could be replaced with a more general ’OK’ Schema, and ANDED with the rest of the Total schema. However I think the way below potentially illustrates what’s going on better.

$$OverwriteTotal == [Overwrite;\ resp! : \{OK\}] \lor WriteFail$$

$$\begin{array}{|l} \multicolumn{1}{l}{\underline{\;Append\;}} \\ \Delta File \\ in? : CHAR \setminus \{EOF\} \\ \hline state = WRITE \\ content' = content \frown \langle in? \rangle \\ state' = state \\ \hline \end{array}$$

$$AppendTotal == [Append;\ resp! : \{OK\}] \lor WriteFail$$

If a user tries to reopen an open file it will not reset the read position.

$$\begin{array}{|l}
\multicolumn{1}{l}{\textit{Open}} \\
\Delta \textit{File} \\
\hline
\textit{state} = \textit{WRITE} \Rightarrow \textit{state}' = \textit{READ} \land \textit{position}' = 0 \\
\textit{state} = \textit{READ} \Rightarrow \textit{state}' = \textit{state} \land \textit{position}' = \textit{position} \\
\textit{content}' = \textit{content} \\
\hline
\end{array}$$

$\textit{OpenTotal} == [\textit{Open};\ \textit{resp}! : \{\textit{OK}\}] \lor \textit{WriteFail}$

$$\begin{array}{|l}
\multicolumn{1}{l}{\textit{ReadChar}} \\
\Delta \textit{File} \\
\textit{out}! : \textit{CHAR} \\
\hline
\textit{state} = \textit{READ} \\
\textit{content}' = \textit{content} \\
\textit{state}' = \textit{state} \\
\textit{position} \in \mathrm{dom}\ \textit{content} \Rightarrow \textit{out}! = \textit{content}\ \textit{position} \land \textit{position}' = \textit{position} + 1 \\
\textit{position} \notin \mathrm{dom}\ \textit{content} \Rightarrow \textit{out}! = \textit{EOF} \land \textit{position}' \notin \mathrm{dom}\ \textit{content} \\
\hline
\end{array}$$

$\textit{ReadCharTotal} == [\textit{ReadChar};\ \textit{resp}! : \{\textit{OK}\}] \lor \textit{ReadFail}$

$$\begin{array}{|l}
\multicolumn{1}{l}{\textit{Close}} \\
\Delta \textit{File} \\
\hline
\textit{state} = \textit{READ} \\
\textit{state}' = \textit{WRITE} \\
\textit{content}' = \textit{content} \\
\hline
\end{array}$$

$\textit{CloseTotal} == [\textit{Close};\ \textit{resp}! : \{\textit{OK}\}] \lor \textit{ReadFail}$