

# **SRAP5101**

FYgYUfWX 'A Yh\cXg 'UbX' Dfc YWi8Yg][b

HYfa 'C bY''##'&\$&%

## 7 ci fgY Cj Yfj ]Yk

### GHJZZ:7cbHJWh:8YHJ]`g

#### 7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`]m	@cWUh]cb	D\cbY
>i b[!Gcc_'@YY	gʻʻYY4 i bgk "YXi "Ui	•	A cfj Yb <sup>·</sup> 6fck b %(\$	-',) '&' &-

#### GWXcc``7cbHJWhʻ±bZcfa Uh]cb

GWXcc``cZGcWJU``GWJYbWYg

Fcca '%) -

A cfj Yb 6fck b 7 &\$

Ya U]`. 'gcgg4 i bgk "YXi "Ui

d\cbY. '\$&'-',) '% \$+

#### 7ci fgY 8YHJ] g

#### 7 fYX]h'Dc]bhg'\*

#### Gi a a UfmcZh\Y 7ci fgY

H\]g`Wci fgY`]bffcXi WYg`h\Y`dfcWYgg`cZWcbXi Wf]b[`fYgYUfW\`UbX`k]``dfYgYbhWcbhYa dcfUfmgcW]U`fYgYUfW\`a Yh\cXg`cZfY`Yj UbWY`fc`h\Y`ghi XmcZdc`]WffxXYj Y`cda YbhUbX`]bhYfbUf]cbU``fY`Uf]cbg"`\\b`h\Y Wci fgYžmci `k]``YI d`cfY`h\Y`dfcWYggYg`]bj c`j YX`]b``cWUf]b[`UbX`a U\_]b[`gYbgY`cZ]bZcfa Uf]cb`UbX`]b [YbYfUf]b[`bYk`]bZcfa Uf]cb`h\fci [\`fYgYUfW\"`7 cj Yf]b[`Vch\`ei U`]hUf]j Y`UbX`ei UbJhUf]j Y`fYgYUfW\\a Yh\cXgž'h\Y`Wci fgY`fYj]Yk g`gi fj YmXYg][ bž`]b!XYdh\`]bhYfj]Yk g`UbX`ZcWi g`[ fci dgž'cVgYfj Uf]cbU`fYgYUfW\`UbX`hYI fi U``UbU`mg]g"`\nci `k]```YUfb`h\Y`WcbWidng`UbX`W\U``Yb[Yg`UggcW]UfYX`k]h\`WcbXi Wf]b[ fYgYUfW\`"\nci `k]```YUfb`f\gYUfW\`XYg][ bžXUfU`Wc``YWf]cbžXUfU`UbU`mg]g`UbX`fYdcff\kf]fj]b["

#### 7 ci fgY @YUfb]b[ Ci hWca Yg

- %" I bXYfgHJbX'h\Y'k \c`Y'fYgYUfW\'dfcWrgg.'Zfca 'WcbWrdhi U`]gUh]cb'UbX'XYg][b]b['U'fYgYUfW\ dfc'YWz'hc'a Yh\cXg'UbX'hYW\b]ei Yg'cZ[Uh\Yf]b[']bZcfa Uh]cbz'hc'XUhJ'UbU'mg]gz'Yh\]Wgz'UbX'fYdcfhl k f]h]b['"
- &" I bXYfqHJbX"h\Y"Y`Ya Ybhq"cZU"`]hYfUhi fY"fYj ]Yk "
- ' " F YWc[ b]gY \_Ymi]ggi Yg i]b fYgYUfW. 'd`Ubb]b[ 'UbX XYg][ b" i
- ("GY`YWiUddfcdf]UhY`a Yh\cXq`Zcf`UXXfYgq]b[`dUfh]W`Uf`fYqYUfW\`dfcV`Ya q"`
- ) " 91 d`U]b`U`fUb[Y`cZVUg]WgcWJU``gWJYbWY`fYgYUfWX`a Yf\cXg`]bWi X]b[`gi fj`YmXYg][b/]bhYfj ]Yk g/UbX`cVqYfj Uf\cbU``fYqYUfWX"

#### HYUWX]b[ GhfUhY[]Yg

HYUW ]b[ 'ghfuh [ ]Yg ']bW XY.

- cb`]bY``YWfi fYq
- ]b!WUgg'k cf\_g\cdg
- ]bXYdYbXYbhk cf\_#UWjj ]hjYg
- Ui h\Ybh\WUqqYqqa Ybhq

 $\label{thm:conditional} $$H_Y^TUh_CbUY_Zcf^h_Y^XYg][b^cZh_]g^hc^fgY_g^hc^fgY_g^hc^fgY_g^hc^fhY^hc^hc^fhY^hc^fhY^hc^fhY^hc^fhY^hc^fhY^hc^fhY^hc^fhY^hc^fhY^hc^fhY^hc^fhY^$ 

#### 5ggYgga Ybh

#### 5ggYgga YbhHUg\_g

5ggYgga Ybh'hUg_	K Y][ \h	8i Y'8UHY	Gh XYbh@YUfb]b[ Ci hWca Yg 5ggYggYX
@hYfUhi fY`fYj]Yk`	(\$1	H65	&
F YgYUfW\`dfcdcgU``	* \$1	H65	' Ž'(Ž')

#### 5ggYgga Ybh8YHJ]`g

5ggYgga Ybh% @]hYfUh fY fYj ]Yk

GhUfhXUhY. Bch5dd`]WUV`Y

@Yb[h\.'%\$\$\$

8 YW] g.

H\]g`UggYgga YbhWcbg]ghg`cZU`%\$\$\$`k cfX``]hYfUhi fY`fYj ]Yk `cb`U`hcd]WcZmci f`Wkccg]b[ "`Mci `k ]```fYWY]j Y k f]hYb`ZYYXVUW\_`UbX`U`bi a Yf]WU``[ fUXY`k ]h\]b`%\$`k cf\_]b[ `XUmg`cZgi Va ]gg]cb`h\fci [ \ 'h\Y`I b]j Yfg]hmfg @YUfb]b[ `A UbU[ Ya YbhgmghYa `fl@A GŁ"`H\Y`ZYYXVUW\_`g\YYh#fi Vf]Wk ]```VY`Uj U]`UV`Y`hc`mci `Uhih\Y`ghUfhcZh\Y`Wci fgY`gc`h\Uhimci `WUb`k cf\_`hck UfXg`gdYW[Z]YX`ghUbXUfXg"

 $\label{thm:continuous} \begin{tabular}{ll} Hi & fb \end{tabular} $$ h' \end{tabular} $$ fb \end{tabular} $$ fb \end{tabular} $$ fo \end{tabular}$ 

5ggYgga Ybh& F YgYUfWX dfcdcgU`

GhUfhXUhY. Bch5dd`]WUV`Y

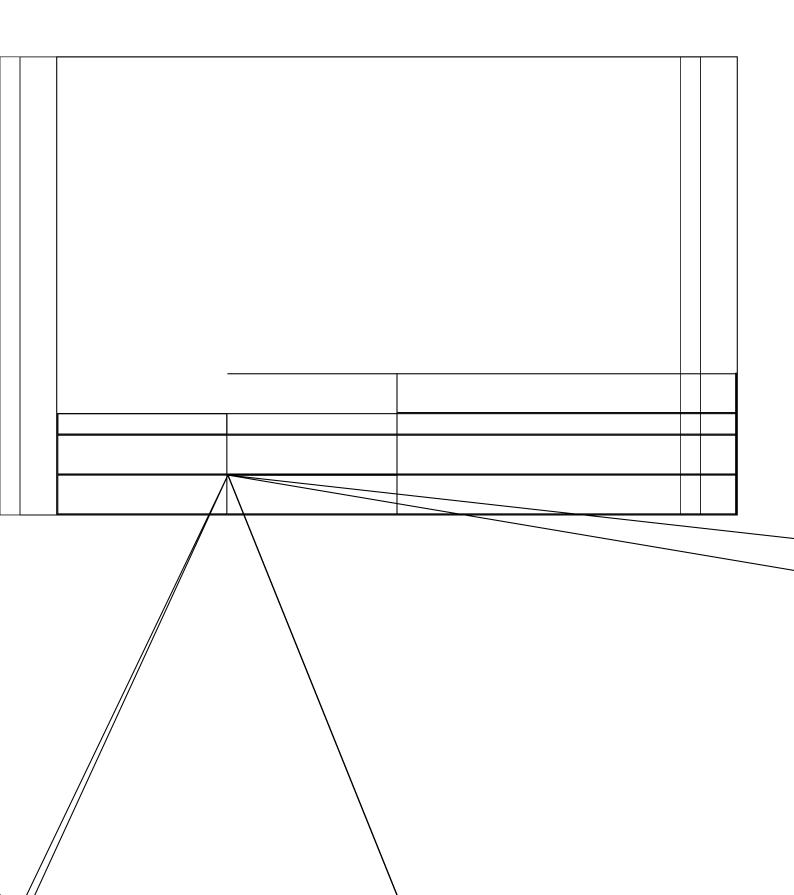
@Yb[h\. '&) \$\$

8 YW] g.

H\]g`UggYgga Ybh'Wcbg]ghg`cZU`&) \$\$`k cfX`fYgYUfW\`dfcdcgU``cb`U'hcd]WcZmci f`W\ccg]b["`Mci `k]``fYWY]j Y k f]hhYb`ZYYXVUW\_'UbX`U'bi a Yf]WU``[fUXY`k]h\]b'%\$`k cf\_]b[`XUmg`cZgi Va ]gg]cb`h\fci [\'h\Y`I b]j Yfg]hmfig @YUfb]b[`A UbU[Ya Ybh'gmghYa `f@A GŁ"'H\Y`ZYYXVUW\_'g\YYh#fi Vf]Wk]``VY`Uj U]`UV`Y`hc`mci `Uh'h\Y`ghUfhicZh\Y`Wci fgY`gc`h\Uh'mci `WUb`k cf\_'hck UfXg`gdY\JZ]YX`ghUbXUfXg"

 $H\ ]g'\ ]g'h\ Y'\ Z\ bU`\ UggYgga\ Ybh'\ Zcf'h\ ]g'\ Wc'i\ fgY''$ 

 $\label{thm:limit} \begin{tabular}{ll} Hi fb]h]b gYH]b[. Hi]g Ugg][ba Ybh]g gi Va]hYX hi fci [in Hi fb]h]b UbX ghi XYbhg WUb gYY Hi fb]h]b g]a] Uf]hm fYdcfhg"$ 



## FYgci fWyg

## DfYgWf]VYX`F Ygci fWYg`

 $\label{eq:hammer_hammer} H \setminus Y \cdot W c f Y \cdot h Y I \ h \cdot \mathbb{Z} c f \cdot h \setminus ]g \cdot g i \ V \cdot Y W h \cdot ]g.$ 

 $\label{eq:hamiltonian} $H \simeq Ug\check{z}; \ "`f\&\$\%+\&"`: ai \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW \ fe"`GU[Y"] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''`GU[Y''] \ And \ fa \ Va \ kagddMeW$dJZ \ bda WUf, \ 3 \ Yg[VWAdefgVW] \ fe''' \ fa \ Va \ had \$ 

# Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g Hi fb]h]b Gi Va ]gg]cb

-Zmci 'YbWci bhYf'U'dfcV`Ya 'k \Yb'UhhYa dh]b[ 'hc'gi Va ]hmci f'Ugg][ ba Ybhh\fci [ \'Hi fb]h]bž'd`YUgY hY`Yd\cbY'9I hYfbU``Gi ddcfhcb'-',)'''' %cf'Ya U]`'h\Ya 'cb'YI hYfbU`hY`hgi ddcfh4 i bgk "YXi "Ui '"'Gi ddcfh

#### 5 WUXYa ]W<cbYghmUbX D`U[ ]Uf]ga

D`U[]Uf]ga i]gii g]b[ih\Yik cfXgicfi]XYUgicZch\YfgiUbXidfYgYbh]b[ih\Ya iUgimci fick b"i=hWbihU\_Yia Ubm Zcfa qžZfca iXYi]VYfUhYiWXYUh]b[ihciUWW]XYbhU`mWcdm]b[iZfca iUigci fWYik]h\ci hUW\_bck iYX[Ya Ybh'

IBGK '[fci dg'd'U[]Uf]ga ']bhc'h\Y'Zc``ck]b[ 'WUhY[cf]Yg.

7 cdm]b[.'i g]b['h\Y'gUa Y'cf'j Yfmg]a ]`Uf'k cfXg'hc'h\Y'cf][]bU`hYl hcf']XYU'k ]h\ci h'UW\_bck `YX[]b['h\Y gci fW'cf'i g]b['ei chUh]cb'a Uf\_g"'H\]g'U'gc'Udd`]Yg'hc']a U[Ygž'Ufh'UbX'XYg][b'dfc YWhgž'Ug'k Y``'Ug dfYgYbhUh]cbg'k \YfY'gca YcbY'dfYgYbhg'Ubch\Yf'g']XYUg'cf'k cfXg'k ]h\ci h'WfYX]h'

± Uddfcdf]UhY 'dUfUd\fUg]b[.'7\Ub[]b['U'ZYk'k cfXg'UbX'd\fUgYg'k\]'Y 'a cghmfYhU]b]b['h\Y'cf][]bU' ghfi WhifY'UbX#cf'dfc[fYgg]cb'cZ]XYUg'cZh\Y'cf][]bU'žUbX']bZcfa UhJcb'k]h\ci hUW\_bck 'YX[Ya Ybh''H\]g'U'gc Udd']Yg']b'dfYgYbhUhJcbg'k\YfY'gca YcbY'dUfUd\fUgYg'Ubch\Yf'g']XYUg'cf'k cfXg'k]h\ci h'WfYX]hUbX'hc d]YW]b['hc[Yh\Yf'ei chYg'UbX'dUfUd\fUgYg']bhc'U'bYk'k\c'Yž'k]h\ci h'Uddfcdf]UhY'fYZYfYbW]b['"

7 c``i g]cb.'k cf\_jb['k]h\ch\Yfg'Vi hdUgg]b['cZZh\Y'k cf\_'Ug'U'dYfgcb'g']bX]j]Xi U``k cf\_"'7 c``i g]cb'U`gc ]bWi XYg'dfcj]X]b['mci f'k cf\_'hc'Ubch\Yf'gh XYbhVYZcfY'h\Y'Xi Y'XUhYžcf'Zcf'h\Y'di fdcgY'cZh\Ya d`U[]Uf]g]b['UhUbmhja Yž'dUm]b['Ubch\Yf'dYfgcb'hc'dYfZcfa 'Ub'UWUXYa]WhUg\_žghYU`]b['cf'UWei]f]b[ Ubch\Yf'dYfgcb'g'UWUXYa]Wk cf\_'UbX'Wcdm]b[']hz'cZZYf]b['hc'Wca d'YhY'Ubch\Yf'dYfgcb'g'k cf\_'cf'gYY\_]b[ dUma YbhZcf'Wca d'Yh]b['UWUXYa]Wk cf\_"

±DUddfcdf]UhY`W]hUh]cb. '7]h]b[ 'gci fWYg'k \]WX`\Uj Y`bchVYYb`fYUXžk]h\ci hUW\_bck `YX[]b[ 'h\Y`″gYWcbXUfm″gci fWY`Zfca 'k \]WX`\_bck `YX[Y`cZh\Ya`\Ug'VYYb`cVhJ]bYX"

- i bXYfgfUbX mci f'f][\hg'UbX'fYgdcbg]V]`]hJYg'Ug'U'gh XYbhUhl BGK
- VY`Uk UfY`cZd`U[]Uf]ga ž`Wcdmf][\hz'l BGK `Gh XYbh7cXY`cZ7cbXi WhUbX`5VWWdhUV`Y`l gY`cZ I BGK `=\forall H`F Ygci f\W\g`Dc`]\m\m
- VY 'Uk UfY 'cZh\Y 'ghUbXUfXg 'cZVY\Uj ]ci f'Yl dYWYX 'cZYj YfmcbY ']b 'h\Y 'l BGK 'Wca a i b]hm
- `cWUHY 'gYfj ]WYg'UbX `]bZcfa UH]cb'UVci hI BGK 'UbX'I BGK '@]VfUfm

Gca Y'cZh\YgY'UfYUg'k]``VY'ZJa]`]Uf'hc'mci ž'ch\Yfg'k]``VY'bYk"'; U]b]b['U'gc`]X'i bXYfgHJbX]b['cZU``h\YfY`UhYX'UgdYWng'cZ9@+69'k]``\Y`d'mci 'a U\_Y'h\Y'a cghicZmci f'ghi X]Yg'UhI BGK "'\\hd.##qi VYWfi |XYg"`]VfUfm'i bqk "YXi "Ui #\`]qY#JVci hY`]qY