

HAULLELUJAH! A SOLUTION TO PACKING A U-HAUL!

ECE 445 Design Document
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1 Introduction

1.1 Objective

<ZnujZ MZ Vhl y{M fjt k nfb` aH aZ{aZx{b'by'Myanx{hnl xl Zt_xnk` ank Z{n'yWannj'nx'Mjnl` hnl xl Zt_xnk` fMMlbnl b` nfZxyZMy{n_jtb` ank ZSuZnujZ MZ Mj, My'nl {aZ`k nFZ`2 nxZ` yuZVb{Mj}tSuZnujZ MZ Mj, My`_b Xb` M Z, `ujWZ`{n Vj}ank Z`X|xb` {aZb`jbZ{tk Z`Aaby'ank Z` Vh|jX`UZ`{Zk unxMx`j{b`Z`MnjZ` Z`Xnxk` nx'uZxk MZI {j{b`Z`Man|yZ`{n y{Mx`M`Mk`b`t`a` k Zxb`M Njhl ZSxn|` ajt`Pa`a`k`bjbnl`jMh|{`Upo`A` k Zxb`Miy`k nFZ`ZMwa`tZM`MjZMy`{nl VZ`AU`?ZMy'nl y` j{b`Z`k nfb` `mxZjvMlbnl` b`{n`M Z, `MIX`UZ`{Zx`ank Z`My', Zjj`My`uZnujZ`{xtb``{n`Zy{Mj}bya`{aZb` n, `I`an|yZanjX`MZ`h`y`{aZ`{nu`{, n`xZMy'nl y`b`Mjnl``j{b`{nl` , a`t`uZnujZ`VanyZ`{n`k nFZ`AU` AaZyZ`y{Mby`{by`Xn`l n`{ZfZl` b`V|XZ`uZnujZ`k nfb`` b`MIX`n|`{n`_{aZ`BI`bZX`@MZY`My', Zjj`My` uZnujZ`k nfb`` , nxjX, bXZ` WnxXb``{n`MB`3`y{|XtSb`{aZ`tZM`YU`Ua`Njhl ZS{aZxZ', ZxZ`M`{n`Mj` n`_Ypa`k`bjbnl`uZxynl`y`k`b`xMlbnl`_xnk`Vh|I`{xt`{n`Vh|I`{xt`AY`A` y`tn|`VM`yZZ`SuZnujZ`MZ`Mj, My` nl`{aZ`k nFZ`5l`Z`n`_{aZ`k ny`{Xb`_b|j`{Mj`y`b`k nfb``by`_b`Xb``MjM`MIX`Z`_bZl`{, M`{n` y`{nxZ`MIX`{xMiyunx`{tn|xUZjnl`b`y`a` k Zxb`M`SuZnujZ`k nfb``{aZb`{Zk`y`Ut`xZl`{b`n|`{` k nfb``{x|Vi`yby`{aZ`yZVhl`X`k`ny`{unu|jM`k`nfb``{ZVal`b`y`Z`xb`a`{UZab`X`uZnujZ`|y`b`{aZb` n, `I`uZxynl`Mj`fZabjZ`{n`Vx`{aZb`UZjnl`b`y`AU`t`nk`uMl`bZy`j{b`Z`B`1) Mj`j`n`Zx`Vhl`y|k`Zxy`M fMxZ`{t`n`_Xb`_bZl`{y`b`X`{x|Vi`y`{n`xZl`{n`{xMiy`Zx`tn|xUZjnl`b`y`a` n, ZfZxSan, `Xn` Vhl`y|k`Zxy`I`n, ` , a`b`a`{x|Vi`y`b`by`bXZMj`nx`{aZk``bZl`{aZb`y`b`MIX`l`k`UZx`n`_UZjnl`b`y`f` `M`{nn`k`Ml`{tk`Zy`uZnujZ', bjj`n`_nx`{aZ`VaZM`Zy`{y`b`{n`jn, Zx`Vny`{nx`{Zjj`{aZk`yZfZy`{aZ` Xn`l`n`{aMfZ`Mj`n`{n`_UZjnl`b`y`a`2`Ml`{tk`Zy`SuZnujZ', bjj`Zl`X`|u`y`{|`_b`{aZb`{Zk`y`b`{n`{aZ` {x|Vi`nx`yw`ZZ`%`{ab`y`b`{n`b`{n`Zl`y|xZ`ZfZxt`{ab``_b`y, b`an|`{xZM`b`{aZ`Vh|jX`UZ` XNk`Mlbnl`n`{aZx`{Zk`y`b`{aZ`uxnVZy`a`3nl`Z`n`_{aZyZ`nu`{bnl`y', nxi', Zjj', aZl`tn|`Z`{n`tn|x` XZy`{b`Mlbnl`MIX`aMfZ`{n`XZMj', b`a`{aZ`MfZ`xk`M`a`n`_aMf`{n`k`nFZ`n|`{Mj`{aZ`Vj|`{ZxZ`{Zk`y` yw`ZZ`%`X`b`{n`{aZ`{x|Vi`a`H`n|jXl`E`b`UZl`bZ`b`{aZxZ', My`Mynj|`{bnl`{aM`l`n`nl`jt`{Zjy`{aZ` Vhl`y|k`Zx', aM`y`b`{x|Vi`{aZ`t`l`ZZX`SU|`{Mj`n`bZy`{aZk`y`{Zu`Ut`y`{Zu`b`y`{x|V`{bnl`nl', aM`MIX` , aZxZ`{aZb`UZjnl`b`y`l`ZZX`{n`UZ`ujWZX`b`nxXZx`{n`Z`_bZl`{j`k`Ml`k`b`%`{aZ`yuWZ`y`

5|`x`nMj`_nx`n|x`uxn`ZV`{y`{n`Z`_ZV`{bZj`MIX`Z`_bZl`{j`t`aZ`ju`k`MIZ`{aZ`uxnVZy`n`k`nfb``nl`Z`y` UZjnl`b`y`b`{n`MIX`n|`{n`_{aZ`{xMiyunx`fZabjZ`ZMy`Z`x`An`k`MIZ`{aby`uxnVZy`ZMy`Z`x`Sn|x`uxn`ZV` Nk`y`{n`My, Zx`{aZ`uxZ`f`n|`j`k`Zl`{bnl`ZX`w`Zy`{bnl`y`n`_b`Xb``Mynj|`{bnl`{aM`{Zjy`Vhl`y|k`Zxy` Z`Mf`j`t', aM`y`b`%`k`nfb``{x|Vi`{aZ`t`l`ZZX`My', Zjj`My`an, {aZ`t`yan|jX`jnM`{aZb`UZjnl`b`y`{n` Z`_bZl`{j`k`Ml`k`b`%`{aZ`yuWZ`a`An`M`Wnk`ujbya`{aby`Z`M`S`b`y`y`k`ujt`Xnl`Z', b`a`M`X`b`b`Mj`{M`Z` k`ZMy|xZ`MIX`M`k`n`U`bZ`M`uj`b`M`bnl`a`AaZ`{M`Z`k`ZMy|xZ', bjj`UZ`|yZ`X`{n`xZ`Vnx`MIX`{xMiy`k`b`{aZ` XMlMhnl`{M`b``{aZ`X`tk`Zl`y`bnl`y`MIX`y`b`y`n`_{aZ`Un.Zy`anjXb``{aZ`Vhl`y|k`Zxy`UZjnl`b`y`a`By`b` Uj|Z`nn`{a`Vhl`I`ZV`{b`f`S`{aZ`XMlM`_xnk`{aZ`{M`Z`k`ZMy|xZ', bjj`UZ`{xMiy`Z`xxZ`{n`n|x`k`n`U`bZ` M`uj`b`M`bnl`{aM`, bjj`l`n`nl`jt`VjM|jMZ`{aZ`bXZMj`y`b`%`k`nfb``{x|Vi`l`ZZX`Z`{n`anjX`Mj`{aZ` UZjnl`b`y`SU|`{Mj`n`bZ`f`y|`Mj`b`y`{x|V`{bnl`y`{n`{aZ`|yZ`x`nl', aZxZ`MIX`an, {aZ`Un.Zy`yan|jX`UZ`

ujMZX' b {n {aZ {x| Vi {n'Z_bvzi {jt'k M.k b%{aZ {x| Vi 'yuWZ^° XX{bni NjtS{aZ'k nUbj' MuijbMlmi , n|jX'uxnfbZ {aZ | yZx'M bZ' b {Zx_MWZ {aM'Njn, y{aZ | yZx{n' i ZZu {xM' n_, ab'a' bZk y'MZ' b 'ZWa'Un..'Mj', Zjj'Mj_b{aZ'Un..'vhl {M' y_xMbjZ bZk y'nxl n{^°

1.2 Background

AaZxZ'MZ'MZ, 'ynj| {bni y{aM'Z. b|' b {aZ'k M'i Z{ {nXM' {aM'aZju'k b b% M'X'ynjFZ' {aZ' unUjZk 'uxnunyZX'MUnfZ' b' k M' b' {aZ'uxnVZyy'n_uM' b' b' bZk y' b' M'k nfb' {x| Vi' k' nxZ' Z_bvzi {M'X'ZM'Zx^° AaZyZ'ynj| {bni y' b' Vj| XZ' M'X' b' b' M'Z' k' ZM' y| xZSn{aZ'x'k nUbj' MuijbMlmi yS M'X'uxn_Zyy' bni M'j'k nfb' 'Vnk uM' bZy^° k' M' t' unu| jM'aM'X, MZ' y{nxZy'jb Z'2 ZI M'XyS1n, ZyS M'X' nk Z'ž Zun{Svhl y| k' Zxy'VM' b' X'Xb' b' M'Z' k' ZM' y| xZy^° y'tn| 'k' M'aM'FZ' | ZyyZX'SXb' b' M'Z' k' ZM' y| xZy' b'Z' vhl y| k' Zxy' {aZ' M'Uj' b' {n' xZVZ' b'Z' Xb' b' M'Z' k' ZM' y| xZk' ZI {y' _xnk' {aZ' bZk' y{aZ' t' MZ' k' ZM' y| xZ' ^°) n, ZfZxSk' M' t' vhl y| k' Zxy'Xn' i n' i l n, 'nx'aM'FZ' {aZ' {b' Z' {n' _b' | xZ' n' | . aM' {n' Xn', b'a' {aZ' xZVZ' b'Z' X' b' ZI y' bni y'nx'an, 'b' VM' UZ' MuijbZ'X' b' {aZ' vhl {Z. {n' _k' nfb' ^° M'X' b'ni S {aZ'xZ' MZ' n{aZ'x'k nUbj' MuijbMlmi yZ. b|' b' b' Mui'k M'i Z{y{ {nXM'SU| {k' M' t' n' {aZ'k' xZfnjFZ' M'X' | X' b' b' | yZxy'Vnyk' Z{b'y' {aM', b'j' k' M'Z' {aZ' ZI {bZ' unVZyy'n_k' nfb' 'ZM'Zx^° @zVobM'NjtS Muiy'jb Z' H | I XZjy| {M'X' @x|jt' b'Z' | yZxy' {aZ' M'Uj' b' {n' k' M'Z' jby' {M'X' {M'Z' b' fZI {nxt' n_, aM' bZk' y' n' b' 'ZWa' Un. SU| {I Z' b'aZx' {Zjjy' {aZ' | yZxy', aZxZ' {aZ' t' yan| jX' uM' {aZ' Un. Zy' b' {aZ' k' nfb' {x| Vi' Z_bvzi {jt' i nx' b'Z' b'Z' M'X'ZI {M' y' b% {x| Vi' y| 'Zy' bni y' ^° XX{bni NjtS n{aZ' k' nfb' 'jM'UjZ'X' Muiy'jb Z' ANyi ? M'U' b' M'X'2 M' b' < jM' M'k' {n' M' y' b' | yZxy' {n' XZ' vhxM'Z' M'X' k' M' M'Z' {aZ' b' i Z, 'ank' Z' | unl' M'X' M'P'3 Z' b'aZ'x' n' {aZyZ' Muiy'aZju' b' {aZ' k' nfb' 'uxnVZyy' M' M'j' ^° b' NjtS {aZ'xZ' MZ' unx_Zyy' bni M'j'k' nfb' 'Vnk uM' bZy' n' {aZ' k' M'i Z{ 'Mj', Zjj^°) n, ZfZxS{aby' nu{bni 'by' Un{a' Z. uZi y' b'Z' M'X' VM' yZy' j' b' b'Zy^° Whx' b' {n' MZ' unx{Sk' nfb' 'Vnk uM' bZy' VaM' Z' Ut' {aZ' an| x' _nx'ZWa', nxi Zx', b'a' ZWa' an| x' VaM' Z' xM' b' _xnk' 'O'ya' {n' O'a' U' M' an| x' ^° Aaby' Vny' {by' _nx' n' l' Z' , nxi Zx' M'hl Z' M'X', b'an| {M'k' nfb' {x| Vi' {nn' ^° AaZ' {n' M' M'Z' xM'Z' Vny' {n' _k' nfb' , n| jX' ZM' b' t' UZ' n' fZx' O'U' U' U', b'a' M'j' {ab' y' vhl y' b'Z' xZx^° < x' b'Zy' M'j' n' x' b'Z' U' M' y' Z'X' n' l' {aZ' X' b' {M' VZ' i Z' Z' X' X' {n' {xM' FZ' {n' Z' {n' {aZ' XZy' b' M' bni ^° Aaby' y'tn| 'VM' y' Z' Z' Sab' b' k' n' fZxy' UZ' Vnk' Zy' M' Z. uZi y' b'Z' nu{bni 'M' b' j' t' w' b' j' t' ^° XX{bni NjtS ynk' Z' Vnk uM' bZy' VaM' Z' vhl y| k' Zxy' Z. {xM, aZi 'aM' X' j' b' _xM' b' Z' bZk' y' ^° Aaby' {M'Zk' ZI {b' y' b' | M'Zy' {aM' b' vhl y| k' Zxy' X' b' i n' {VannyZ' {aby' nu{bni S, nxi Zxy' k' M' i n' {uxnuZ' j' t' aM' X' j' Z' M' uZ' xynl' y' UZ' jni' b' y', b'a' VM'Z', ab'a' VM' VM' yZ' j' b' b'Zy' _nx' {aZ' vhl y| k' Zx^°

1.3 Visual Aid

' b | xZ' U' yan, y' Mab' a' jZ' fZj' b' {Zx' M' {bni 'n' n' | x' unx' t' ZV{^° AaZ' | yZx', b'j' k' ZM' y| xZ' M' Un.. y' {axZZ' X' b' ZI y' bni y' | y' b' {aZ' X' b' b' M'Z' k' ZM' y| xZ' S' M' X' {aZ' Uj| Z' {nn{a' k' nX| jZ' b' {aZ' {M'Z' k' ZM' y| xZ', b'j' yZi X' {aZyZ' k' ZM' y| xZk' ZI {y' {n' M' vhl | ZV{Z' X' k' nUbj' XZ' f' b' Z' {axn| ` a' Uj| Z' {nn{a^° AaZ' k' nUbj' XZ' f' b' Z' , b'j' xZVZ' b'Z' {aZyZ' b' u| {y' M' X' X' b' u' j' M' {aZk' 'VjZ' M' j' t' {n' {aZ' | yZx' {axn| ` a' {aZ' MuijbMlmi ^°

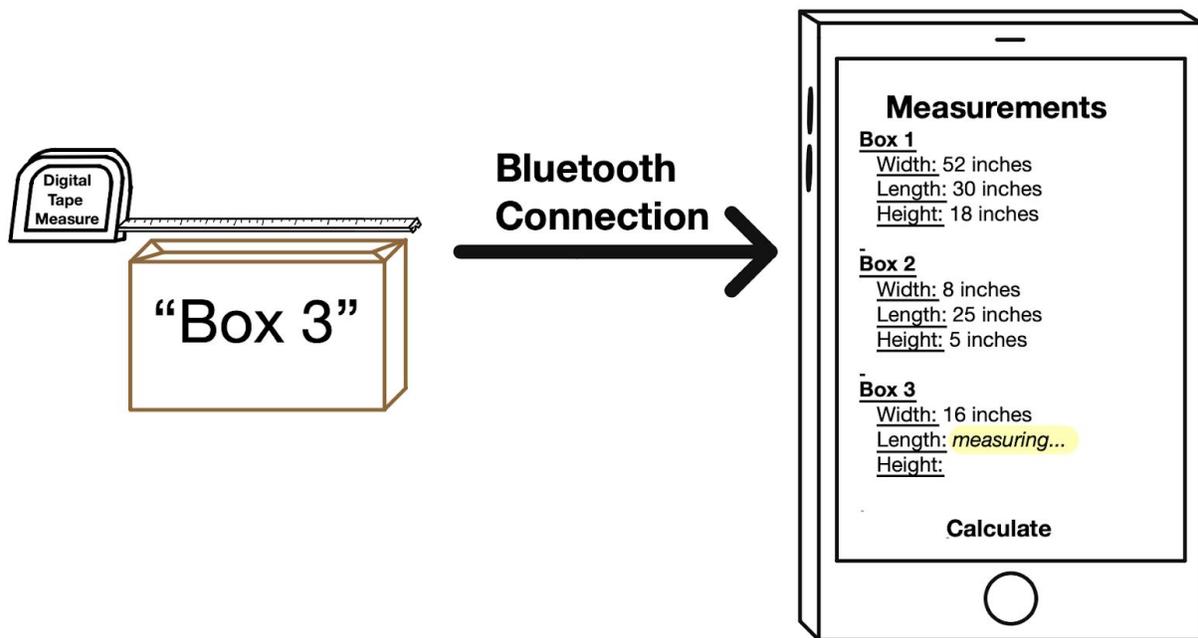


Figure 1. Sending Measurement Visual Aid

1.4 High-Level Requirements List

3/4" 2 nUjZ' MdujBMl 'Nj' nxdak 'k | y{ 'MW' xMzjt' M'X'Z' ZV{bfZjt' XZ{Zxk b Z' {aZ' ybZ'n_k nfb` ` {x| Vi 'l ZZXZ' _nx' {aZ' | yZx' UMYZX' nl ' b Vnk b ` | yZx'k ZMY| xZk ZI { 'XMIMb ' | I XZx' Y'k b | {Zy' a'

3/4" 2 nUjZ' MdujBMl 'k | y{ 'XbyujM' M'fy| Nj' b {Zx' MW' XZ{M}b ` 'an, ' | yZxy'yan| jX'jnM' {aZ' b' UZjnl ` b ` y' b {n' {aZ' k nfb` ` {x| Vi {n' Z' bZl' | j' t' k M. b k bZ' yuMW' {axn| ` a' y{Zu' Ut' y{Zu' b' y{x| V{bl' y' a'

3/4" E|j Z{nn{a' k nX| jZ' M{MwaZ' {n' Xb' bMj' {Muz' k ZMY| xZ' ZW' buZX', b'a' M'jZMY' nl Z' U| {{nl S{, n' y{M| yjb' a{ySM' X' Mun, Zx' 53µ5' ' ' k ZVaM' byk Ak | y{ 'MW' xMzjt' M'X'Z' ZV{bfZjt' {xM' yk b' {aZ' Xb' bMj' {Muz' k ZMY| xZ' k ZMY| xZk ZI { 'XMIM' n' {aZ' k nUjZ' MdujBMl ' b' M' b' k Zjt' k M' I Zx' yZVnl Xy' A'

2 Design

2.1 Functional Overview

' nx'n| xXZyb| {n' UZ' y| WZyy_ | j' t' nuZxMl' Mj' b' yM' b' j' b' ` n| x' uxn' hZV' { ' uxn' UjZk S' b' l' ZZXy' {n' UZ' Vnk uxyZ' X' n' _n| x'y| Uyty{Zk y' vnl {xnj' | l' b' SuxZ' Z' . by{b' ` {Muz' k ZMY| xZ' Sun, Zx'y| uuj' t' SM' X'

k nUqZ MuijBMlml a"" Wa'y| Uyty{Zk 'by'MfMj'Vnk unl ZI {{n' {aZ'nfZxMj' XZyb| 'MIX', aZl ' Vnk Ub ZX'n` Z{aZxU| hXy'MuxnX| V{, Z'UZjZfZ', h'j'ynjZ'n| x'uxnUjZk 'y{Mzk ZI {^AaZ'un, Zx' y| uujt'Vnl {Nb'y{aZ'l ZVzyMst hZk y{n'MXZw' MZj't'un, Zxn| x'k b'xnVnl {xnjjZxS, ab'a', h'j' b' {l' x' un, Zx{aZ'Uj| Z{nn{a'k nX| jZ'n' {xM'y_Zx{aZ'k ZMj| xZk ZI {XMM{n'n| x'k nUqZ MuijBMlml ^AaZ' Vnl {xnj'| l' h'y| Uyty{Zk ', h'j'an| yZ'n| x'k b'xnVnl {xnjjZxSUj| Z{nn{a'k nX| jZSMIX'M_Z, 'Vnyk Z{b' hZk y'jB'Z'U| {{nl y'MIX'1" ž y^AaZ'` nM'n_ {aby'y| Uyty{Zk 'by' {n' xZVZb'Z' | yZx'b' u| {y' _xnk' {aZ' U| {{nl y'My', Zjj'My' xZVZb'Z' k ZMj| xZk ZI {XMM_xnk' {aZ'uxZ'Z. by{b' ` Xb' h'Mj' {Muz'k ZMj| xZ' ' b' Mj'tS{aby'y| Uyty{Zk ', h'j'n| {u| { {aZ'k ZMj| xZk ZI {y' xZVZb'Z'X' f'BMUj| Z{nn{a' {n' {aZ'k nUqZ' MuijBMlml ^AaZ'uxZ'Z. by{b' ` {Muz'k ZMj| xZ' y| Uyty{Zk 'Vnl {Nb'y'M' Mj'kZM't'Z. by{b' ` Xb' h'Mj' {Muz' k ZMj| xZ'n| {aZ'k M' Z' {nXMS, ab'a', Z', h'j'| yZ' {n' -aM' ®b' {n' h'y'Xb' h'Mj'XbyujM' {n' ubuZjB' Z' {aZ' k ZMj| xZk ZI {XMMb' {n'n| x'Vnl {xnj'| l' h^AaZ'k nUqZ MuijBMlml 'y| Uyty{Zk 'by'Vnk uxbyZX'n_M k nUqZ Mui {aM', h'j'| yZ' {aZ'uanl Z-y'Uj| Z{nn{a' Vnl l' ZV{b'nl' {n' xZVZb'Z' {aZ'k ZMj| xZk ZI {XMM MIX'uzX_nx' M' Mj' n'x'ak' {aM', h'j' VnxZVj't'XZ{Zx' b' Z' {aZ' y'Z' n_ {x| M' l' ZZX' _nx' {aZ' | yZx^Aaby' y| Uyty{Zk ', h'j' Mj'n' uxnf'XZ' {aZ' | yZx', h'a' M'f'y| Mj'b' {Zx_MZ' n_, aZxZ' {aZ't'yan| jX'ujMwZ' {aZ'b' UZjnl' ` b' ` y'My', Zjj^a'

' b | xZ'Y'yan, y'MUjnV' Xb'MxM' Vnl {Nb' b' ` {aZ'uatyb'Mj'b' {ZxM' {b'nl y'n_ {aZ'k M' t'uM' {y'n_n| x' uxntZV{^a'

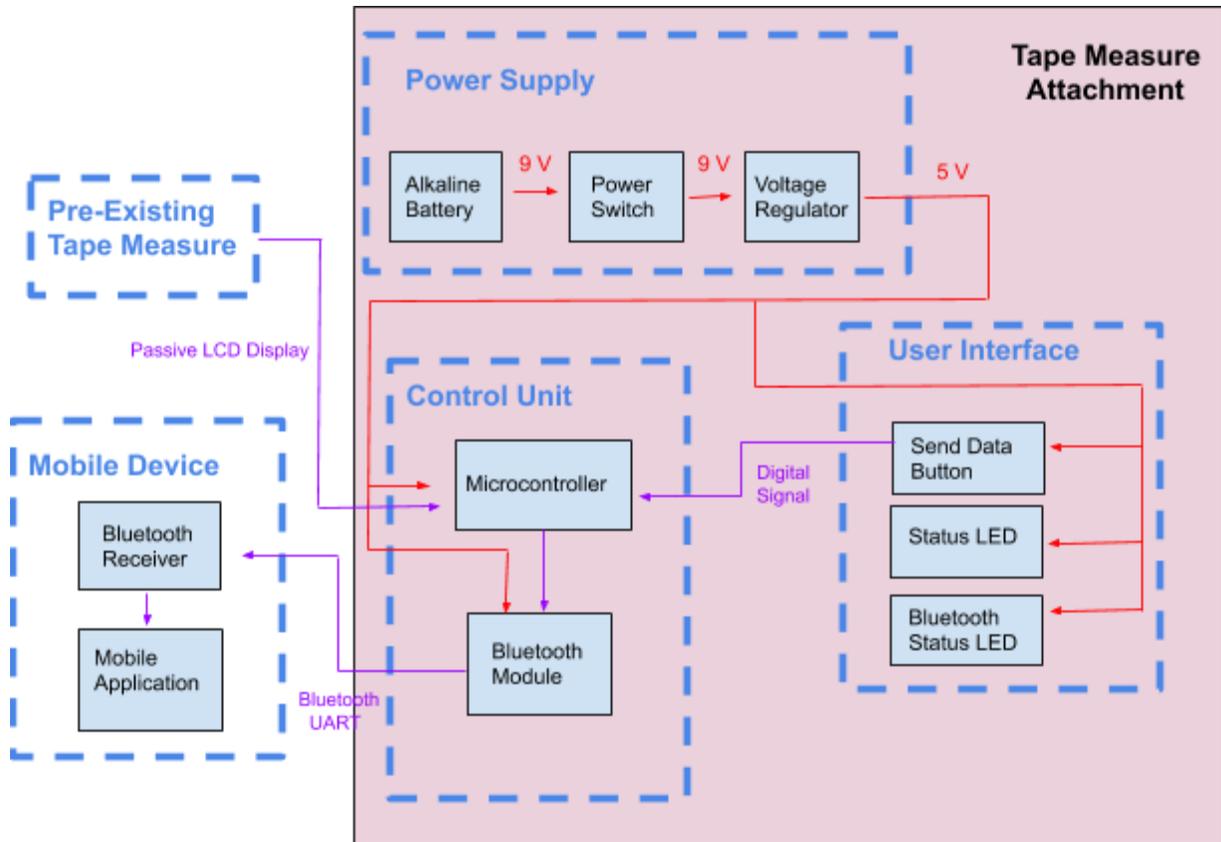


Figure 2. Block Diagram

2.2 Physical Design

At the end of the design process, the physical design is completed. This involves the final layout of the PCB, including the placement of components and the routing of traces. The physical design is then used to generate a Gerber file, which is used to manufacture the PCB. The physical design also includes the design of the enclosure, which is used to protect the PCB and its components. The enclosure is designed to be compact and efficient, with a focus on minimizing the size and weight of the device. The physical design is a critical step in the development of a PCB, as it determines the final appearance and performance of the device.

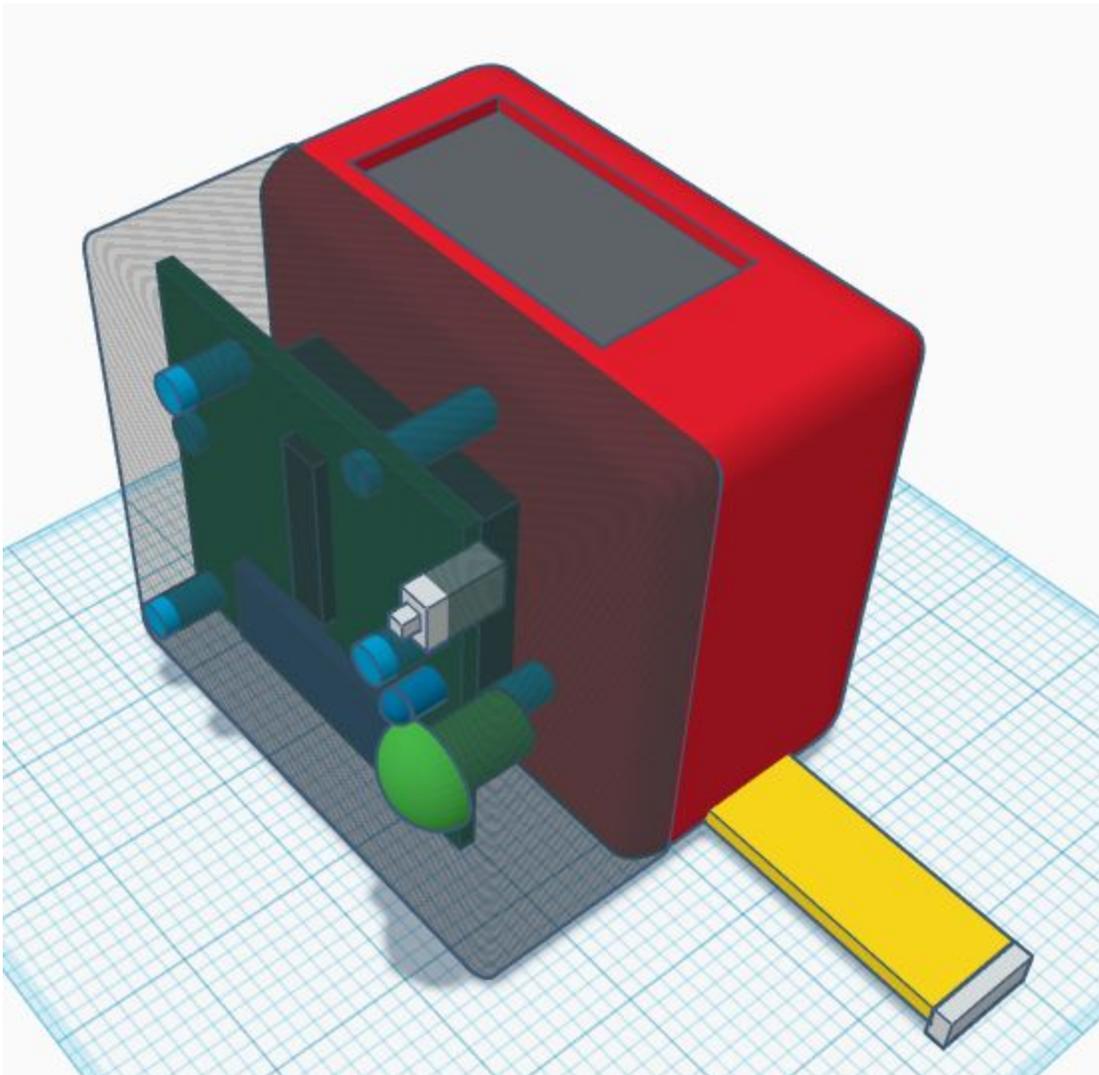


Figure 3. Physical Design

2.3 Power Supply

AaZxZ'NX'fNxb|y'Vnk unl Zl {y'UZb` `NXZX{n{aZ'k ZMyl xZ', abVa xZw' bZ'un, Zx'n' nuZxMZ'aAaZyZ' b' Vj| XZ' {aZ'k b'XnVnl {xnjjZxS(aZ'Uj| Z{nn{a'k nX| jZSjb a{ySMIX'U| {ni y'aH b'a' {aby'UZb` `y'NXS' b'y| ZVZyM' _nx| y'n'XZy' l' Mun, Zx'y| uujt', abVa', b'j'un, Zx' {aZyZ' {ab` y'a' AaZ'un, Zx'y| uujt', b'j'UZ'k NXZ' | u'n_{aZ' _njjn, b` @y' Nj' Z'UM{ZxZySun, Zx'y, b'VaSMIX' fnj{MZ'xZ' | jMnx'a

2.3.1 Alkaline Batteries

Bj{tk MZjtSZfZxt{ab` un, ZxZX'b' {aZ'Vnl {xnj| l' b', b'j'UZ'un, ZxZX'Ut'UM{ZxZy'aAaZ'UM{ZxZy' , Z'ub' l' ZZX' {n'aMfZ'Mab a'Zl n| ` a'fnj{MZ' {n'i ZZu'ZfZxt{ab` un, ZxZX'SMIX' {aZ't l' ZZX' {n' aMfZ'Zl n| ` a'VMiM' b' {n'i ZZu' {aZ'Xb' b'Nj' {Miz'k ZMyl xZ' nuZxM' b` ` _nx' M' Z. {Zl XZX' M' n| l' {n' _ {tk Z'a' l' M' {Zxt' fnj{MZ', b'j'UZ' M' ujjZx' {n' M' fnj{MZ' xZ' | jMnxSyn' b' b'ni M' _nx' {aZ' {n' M' fnj{MZ' Vnk b` ` _xnk' {aZ'UM{ZxZy' {n' Z. VZZX' {aZ' fnj{MZ' l' ZZXZX' _nx' {aZ'k b'XnVnl {xnjjZxUj| Z{nn{a' k nX| jZ'a

Requirement	Verification
<p>äG'UM{Zxt'k y{UZ' MjZ' {n'y uujt'UZ{, ZZl' ä'a'a'ä'p'G'MIX'aÜ'ÜÜÜ'k` ` {n' {aZ' fnj{MZ' xZ' jMnx'a</p>	<ul style="list-style-type: none"> ° a Byb` ` M' nyM' jnyVhuZ'SyZ' {1' u' M' {Zy' {b` ` Zl f' b' n' l' k' Zl { _nx' {aZ' <n, Zx' @ uujt' y Uyty{Zk` £ a ' j' b' {aZ' un, Zx'y, b'Va' {n' {aZ' '53' uny' b' l' a' † a 2 n' l' b' n' x' {aZ' fnj{MZ' n' l' {aZ' nyM' jnyVhuZ' M' {aZ' b' u' {n' _ {aZ' fnj{MZ' xZ' jMnx'a ž a " l' y xZ' fnj{MZ' xZ' VZ' b' Zx' b' y'UZ{, ZZl' ä'a'a' G' ä'ä'p'G'a
<p>£ M' {ZxZy'k y{UZ' MjZ' {n' j' M' {k n' xZ' {aM' Ü' an x' n' _ l' n' k' M' yZ' Ut' {aZ' Vnl {xnj l' b' y Uyty{Zk` a'</p>	<ul style="list-style-type: none"> ° a @ b'Va' {aZ' un, Zx'y, b'Va' {n' {aZ' '53' uny' b' l' a' £ a " l' y xZ' t' n' l' {xnj' B' l' b' y Uyty{Zk' b' y' V xZl' {j' _ l' V' {b' l' b` ` Ut' fZx' b' t' b` ` {aZ' @M' y' 1" ž' b' y' j' b' u' n' _ n' j' b' X' V' n' j' n' x' a' † a £Z' b' {tk Zx' Z' b' {aZ' x' n' l' yk' M' {uan' l' Z' n' x' y' {nu, M' Va' A' ž a £Z' b' k' ZMyl x' b` ` b' Zk' y' M' X' y' Zl' X' b` ` XM' M' n' fZx' Uj Z{nn{a' " a H' aZl' {aZ' {tk Zx' b' y' M' aÜ' k' b' {Zy' ü' an x' S' y' {nu' b' M' X' Zl' y xZ' 1" ž' y' n' l' k' b' XnVnl {xnjjZx' MZ' y' {b' j' b' u' M' X' y Uyty{Zk' b' y' {b' j' _ l' V' {b' l' b` ` a'

2.3.2 Power Switch

Ani ZZU {aZ UM {ZxZy jM {b` Myjnl` My`uny yUjZSMYk Nj y, bVa` j b ZjtSMYj bXZ y, bVaA, b j`UZ` | yZX`n`ZI MUJZ`{aZ`| yZx`n`{ | xl`nl` M`X`n`_un, Zx`n`{aZ`fnj`{MZ`xZ` | jM`nx`SM`X`{a`| yS`{aZ`Vnl`{xnj` | l`b`a`

Requirement	Verification
<p>2 y`y` WZyy`jjt`Xb`Vhl`I`ZV`un, Zx`_xnk` fnj`{MZ`xZ` jM`nx`, aZl` y, bVaZX`5`'` M`X` y WZyy`jjt`Vhl`I`ZV`un, Zx`n`{aZ`fnj`{MZ`xZ` jM`nx`jU`UG`XxnuA, aZl` y, bVaZX`5`3`a`</p>	<ul style="list-style-type: none"> ° a H b`ab` {aZ`<n, Zx`@` uujt`y Uyty`{Zk` S yZ`{` u`M`{Zy`{b``ZI`f`bxl`k`ZI`{` yb`` {aZ`ny`M`j`ny`VhuZ`a` £ a <xnUZ`{aZ`un, Zx`y, bVa`a`*` b`b`j`j`S`yZ`{` {aZ`y, bVa`b`{aZ`5`'` uny`b`l`a` † a "I`y xZ`I`n`fnj`{MZ`by`jn, b`n` `{n`_{aZ`un, Zx`y, bVa`a` ž a 'j`b`{aZ`un, Zx`y, bVa`{n`{aZ`5`3` uny`b`l`a` " a 2`nl`b`nx`nl`{aZ`ny`M`j`ny`VhuZ`{aM`fnj`{MZ`by`UZ`b`uxnX VZX`_xnk`{aZ`un, Zx`y, bVa`jU`UG`XxnuA` ' a 'j`b`{aZ`un, Zx`y, bVa`UM`{n`{aZ`5`'` uny`b`l`a` (a 2`nl`b`nx`nl`{aZ`ny`M`j`ny`VhuZ`{aM`{aZ`un, Zx`y, bVa`y WZyy`jjt`xZX VZ`fnj`{MZ`n`{aZ`fnj`{MZ`xZ` jM`nx`

2.3.3 Voltage Regulator

@nk`Z`{tk`Zy`S`b`y`Xb`b`| j`{`_nx`UM`{ZxZy`{n`k`N`b`{N`b`M`V`Z`x`{N`b`fnj`{MZ`n`f`Z`x`M`I`Z`{Z`I`X`Z`x`u`Z`x`n`X`n`_`{tk`Z`a`*_`V`Z`x`{N`b`V`nk`unl`ZI`{y`x`Z`w`b`Z`y`{Z`M`k`f`fnj`{MZ`j`Z`f`Z`j`y`S`b`b`l`f`b`X`Z`M`{n`x`Z`j`n`l`UM`{ZxZy`{n`M`W`nk`uj`b`y`{a`b`y`Z`M`a`*`X`X`b`l`n`l`M`j`j`S`b`b`l`f`N`l`M`y`uny`y`U`j`Z`{n`u`b`i`n`|`{`UM`{Z`x`{`V`nk`U`b`M`l`n`l`y` , ab`v`a`k`Z`Z`{`V`Z`x`{N`b`fnj`{MZ`x`Z`w`b`Z`k`ZI`{y`j`_nx`Z`M`k`uj`Z`S`°`UM`{ZxZy`M`Z`x`M`Z`X`M`I`U`a`G`{`x`t`b``{n`uxnX| VZ`M`fnj`{MZ`j`Z`f`Z`j` , ab`v`a`b`l`f`M`k`| j`{b`uj`Z`n`_U`a`G`U`Z`V`nk`Zy`Xb`b`| j`{A`A`a`Z`x`_nx`Z`S`{aZ`V`nl`V`Z`u`n`_fnj`{MZ`xZ` | jM`nx`y`U`Z`V`nk`Zy`| yZ`_j`a`*`n`| x`ux`n`l`Z`V`{S, Z, b`j`UZ`un, Z`x`b`M`k`b`x`n`V`hl`{xnj`Z`x`M`I`X`M`U`j`Z`{nn`{a`k`n`X`| j`Z, ab`v`a, b`j`j`b`Z`j`t`x`Z`w`b`Z`y`u`Z`V`b`b`fnj`{MZ`j`Z`f`Z`j`y, ab`v`a`M`Z`X`b`_Z`x`Z`I`{`{a`M`{aZ`UM`{ZxZy, Z`u`b`i`a`£`†`| yb``fnj`{MZ`xZ` | jM`nx`y`S, Z`V`M`I`y`| uujt`{aZ`V`n`x`Z`V`{fnj`{MZ`y`{n`{aZ`y`Z`V`nk`unl`ZI`{y`Z`f`Z`I`{an`|`a`n`| x`UM`{ZxZy`k`M`I`n`{Z`M`W`j`t`k`M`V`a`{aZ`y`Z`y`M`k`Z`fnj`{MZ`y`a`

	<p>k ZMyl xZk Zl {y'XbyujMZX'nl {aZ' l n{bMl'nl b {Zx_NWZ'NZ' {aZ'yMk Z'Ny' {aZ'nl Zy'xZVnxX'nl 'uMizX'</p>
<p>2 y{ 'UZ' MljZ' {n' {xMlyk b'k ZMyl xZk Zl { 'XMIM fMlj Z{nn{a' {n' MuMkZX'XZfVZ'a'</p>	<p>° a <xZyy{aZ' <Mk'U {{nl ' , b'ab {aZ' t nl {xnj'Bl b'y Uyty{Zk ' t a 5l 'Mk nUbjZ'XZfVZS yb' `Uj Z{nn{a' Vhl l ZV{b'f'fSuMk' , b'a {aZ'Uj Z{nn{a' k nX jZ' t a (MlaZx'k ZMyl xZk Zl { 'XMIM yb' ` {aZ' uxZ'Z. b'y{b' ` {Miz'k ZMyl xZ' ž a <xZyy{aZ'@l X'ž MIMU {{nl ' " a "l y xZ' {aZ'XMIM, M'y'xZVZb'fZX'nl {aZ' k nUbjZ' MuijbMl'nl 'Uf'fZ' , b' ` {aZ' k ZMyl xZk Zl { 'XMIMhl {aZ' l n{bMl'nl b' {Zx_NWZ'nl {aZ'k nUbjZ' MuijbMl'nl '</p>

2.4.2 Bluetooth Module

AaZ'' xX| b' n' EA' | yZyM'lj | Z' b' MH AÜÜ'Uj | Z{nn{a' k nX| jZ' {aM' , Z' VM' | yZ' , a bZ' uxn{n' {tub' ` MlX' anuZ' _jjt' b' ujZk Zl { 'b' 'n| x'uVU' Aaby'Uj | Z{nn{a' k nX| jZ' , b'j' UZ' xZyuni yb'ljZ' _nx'xZVZb'f' ` XMIM _xnk {aZ'' Ak Z' M'Y'a < 2 b'xnVnl {xnjjZx'MlX'yZl Xb' ` b' {n' {aZ' 2 nUbjZ' ž ZfVZ'a' * {aM'y' M' nuZxMl' b' ` fnj{MZ'n_Ý'a' {n' b'a' G' , ab'a' b'y' , Zjj' , b'ab' {aZ' , b' Xn' , ' , Z' , Ml { 'ÄÄ'' jynSb' aM'y' M'XM' Z'n_ pàÜ' k Z{Zxyjb' Z'n_ 'yb' a' , ab'a' b'y' k nxZ' {aM' 'Zl n| ` a' yb' VZ' {aZ' | yZx' , b'j' aM'Z' {aZ' b'y' k M' {uanl Z' k ny{ 'jb' Zjt' jZyy' {aM' 'ä' k Z{Zxy' _xnk {aZ' Uj | Z{nn{a' k nX| jZ' 'ÄÄ''

Requirement	Verification
<p>tj Z{nn{a' k nX jZ' k y{ 'UZ' MljZ' {n' yZl X' k ZMyl xZk Zl {y' {n' {aZ' yk M' {uanl Z' NW xMjZt' , b'a' M' {xMly_Zx'yuzZX'n_ M' jZMyl 'Ý' 2 Uuy'a'</p>	<p>° a ž Zybl ' MlX' b'k ujZk Zl { M' {Zy{ 'uxn' xMk' yb' ` {aZ'' xX b' n' yn_ , MZ' {aM' , b'j' uxb' {n { 'Uj Z{nn{a' {xMly_Zx'xMjZ' {n' yZx' b'y' k nl b'nx' t a ? ' {aZ' {Zy{ 'uxn' xMk' t a "l y xZ' {aZ' {xMly_Zx'xMjZ' _xnk {aZ' Uj Z{nn{a' k nX jZ' b'y'n_ M' jZMyl 'Ý' 2 Uuy'</p>

2.4.3 Send Data Button

Requirement	Verification
<p>2 y{ 'UZ'j{, b{a 'Mynj{Vnjnx', a{bZ'Uj Z{nn{a' k nX jZ'by'Vnl ZV{ZX\$Uj{b i b`', a{bZ' Uj Z{nn{a' k nX jZ'by'yZM{Vab`'_nx'Mk nU{bZ' XZ'f{bZ\$MIXI n{ j{q'n{aZx, byZ'a'2 y{ 'UZ'f{y{bUjZ' _xnk 'U'k Z{Zx'M, M'a'</p>	<p>° a ž n' l n{ 'uM{Uj Z{nn{a' k nX jZ', b{a' k nU{bZ' XZ'f{bZ'a'</p> <p>Ł a 2 ZM xZ'n { 'U'k Z{Zx'M, M'_xnk {aZ' 1" ž'</p> <p>† a " l y xZ' 1" ž 'by'Uj{b i b`' f{y{bUj{t'</p> <p>ž a <M{Uj Z{nn{a' k nX jZ', b{a' k nU{bZ' XZ'f{bZ'</p> <p>" a " l y xZ' 1" ž 'by'n_ynj{Vnjnx'MIX'f{y{bUjZ'</p>

2.5 Mobile Device

AaZ'Vnl {xnj| | b{, b{y'Zl X'XM{M{axn| `a'Uj| Z{nn{a' B' ?A' {n' {aZ' k nU{bZ' XZ'f{bZ'a' Aaby'XZ'f{bZ', b{y' xZVZ'fZ'f{y{ZySy{nxZ' {aZk' b' M'k nU{bZ' M'uj{b'M{bni S{b u| { {aZk' b' {n' M' M' n{x{ak \$MIX'X'byujM' {aZk' b' M'f{y{M' n{x' {aZ' | yZx' n' i l n, ', aZxZ' {n' y{nxZ' {aZ' b' bZk' yMIX'an, 'k | Va' yuWZ', b{y' UZ' xZw| bZX'a''

2.5.1 Bluetooth Receiver

AaZ' | yZx', b{y' aM'Z' M' Z. by{b`' yk M{uanl Z' {aM', b{y' UZ' M{JZ' {n' uM{ {n' n' | xUj| Z{nn{a' k nX|jZ' b' n| x'Vnl {xnj| | b{a''

Requirement	Verification
<p>Łj Z{nn{a' xZVZ'fZ'x'n ` yZx-y'yk M{uanl Z' k y{ 'UZ' M{JZ' {n' Vnl ZV{ {n' Uj Z{nn{a' k nX jZ' f{bUj Z{nn{a' Vnl ZV{b'f{t'</p>	<p>° a 5l 'M'k nU{bZ' XZ'f{bZ'\$nuZl 'Uj Z{nn{a' Vnl ZV{bni 'yZ'{{b`' y'b {Zx'WZ'</p> <p>Ł a ' b' X' {aZ' VhxxZyuni Xb`' Uj Z{nn{a' k nX jZ' XZ'f{bZ' l M' Z'n 'aZ' Vnl ZV{bni yjby{'</p> <p>† a 5l {aZ' k nU{bZ' XZ'f{bZ'\$M' {n' Vnl ZV{muM{, b{a' {aZ' Uj Z{nn{a' k nX jZ'</p> <p>ž a " l y xZ' Vnl ZV{bni 'by'k M{Z' {axn `a' l n{ b{b'M{bni y'n {aZ' yk M{uanl Z-y' b' {Zx'WZ'a'</p>

2.5.2 Mobile Application

5 | x'k nUqZ MuijBMl ' , b'j xZVZbZ fMj Zy_xnk {aZ Uj| Z{nn{a xZVZbZxSy{nxZ {aZk 'b {aZ MiuS x| l 'M 'Mj nxdak {aM jnni y_nx{aZ UZy{ujWZy{n y{nxZ {aZ Un. Zy'b {aZ {x| V S{Zj {aZ | yZx , aM ybZ{x| V byxZw bZXSMX'yan , Mfby| M'n_ , aZxZ {n y{nxZ {aZ bZk y'b {aZ {x| V a''

Requirement	Verification
<p>AaZ Mj nxdak 'l ZZxy{n XZVZX' , aZxZ bZk y' k y{UZ'ujWZX'MX{MIZjZyy{aM Y'k b {Zy' {n Vnk u {Z'a</p>	<p>° a 5l 'k nUqZ XZfVZSZl y xZ Mj XMIM k ZMj xZk Zl {byyZl {Uf uxZyyb ` {aZ @Zl Xž MIMU {{nl ' t a ? l {aZ Mj nxdak ' f a ByZ'My{nu , M'Va M'X'y{M' b' ž a @nu{aZ y{nu , M'Va , aZl {aZ l n{bBMl b {ZxWZ XbyujM'y'nl {aZ k nUqZ XZfVZ y{Mb ` Mj nxdak by Vnk ujZ{Z' " a "l y xZ y{nu , M'Va {bZ Z byjZyy{aM Y' k b {Zy'</p>
<p>AaZ Mj nxdak 'k y{UZ'MjZ {n xZunx{ {aZ yk MjZy{ unyyWjZ ybZ{x V l ZZXZX' _nx{aZ yZx{n y{nxZ {aZ bZk y'a</p>	<p>° a 5l {aZ k nUqZ XZfVZSZl n{bBMl 'yan jX MiuZM{aM {aZ Mj nxdak by Vnk ujZ{Z'a t a ByZxy'yan jX {aZl UZ'MjZ {n yZZ xZy j{y'n_{aZ Mj nxdak ' f a GZ , xZy j{ ž a lnni 'nl {aZ uMl b ` {x V , ZUyqZ ž'a aB1) MjA{n Zl y xZ {aZ xZy j{ xZVZbZX' , Mj l n{ {aZ Ub ` Zy{ {x V ybZ'a</p>
<p>AaZ Mj nxdak 'k y{XbyujM'nl Z'ynj {b'nl _nx' {aZ k ny{Z_bZl { , M' {n uMl {aZ {x V a''</p>	<p>° a 5l {aZ k nUqZ XZfVZSZl yZxy'yan jX xZVZbZl n{bBMl y{Mb ` {aZ Mj nxdak by Vnk ujZ{Z'a t a Bunl Vnk ujZ{b'nl _n_{aZ Mj nxdak S k nUqZ MuijBMl 'yan jX XbyujM'nl {aZ yZxMjy{n_Z_bZl {uMl b ` ynj {b'nl y' f a ByZxy , b'j {aZl aMfZ {aZ nu{b'nl {n fZ , Mj unyyWjZ ynj {b'nl yM'X VannyZ MWnxXb ` jt {aZ UZy{ ynj {b'nl {aZ t yZZ b' }</p>

2.6 Pre-existing Tape Measure

5 | x'MdujbmMlbnl 'l ZZXynUHzV{y-Xtk Zl ybnl y'b 'nxXZx{n 'VMj} jMz {aZ'UZy{', M' {n'uMl 'kZk y'b 'M Vhl _b ZX'yuWZ^AaZyZ'Xtk Zl ybnl yS| j{tk MZj+S, b'j'UZ'Zl {ZxZX'b 'Ut {aZ' | yZxn_n| x'MdujbmMlbnl ^a' AaZ'w' bM Zx{aZ' | yZx'VMl _b | xZ'n| { 'Xtk Zl ybnl y'n_{aZ' {ab' `y'aZ'pYaZ' by'k nfb' `S{aZ'k nxZ' | yZ' j' n| x'MdujbmMlbnl ', b'j'UZ' {n'atk paZx^5 | x'ynj| {bnl ' {n'k b' tk bZ' {aZ' M' n| | {n'_{tk Z' _nx{aby'uxnVZyy' by'n | yZ' MuxZ'Z. by{b' `Xb k'Nj' {Miz'k ZMj| xZ'Sxn| {Z' {aZ'k ZMj| xZk Zl {xZ'Nkb' `y_xnk 'kSMIX' yZl X' {aby'XMlMh'fZx'Uj| Z{nn{a' {n'n| x'MdujbmMlbnl ^a'

Requirement	Verification
A Miz'k ZMj xZ'k y{ 'aM'F' MWZyy'UjZ' M'X' yMjZ' XMlMyb' l Mjy', ab'va' VMl 'UZ' yZX'Ut'n x' Vhl {xnj' l k^a'	<ul style="list-style-type: none"> ° a ž ZVhl y{x V{ 'uxZ'Z. by{b' ` {Miz' k ZMj xZ' £ a GkZ, 'Z. by{b' ` ZjZV{xnl b'yn_{Miz' k ZMj xZ'SyuZVb'VMj' XMlMyb' Zy' {aM' xn {Z' {n' XbyujM'nl ' {Miz'k ZMj xZ' † a † aZV' {aZyZ' yb' l Mjy' {n'yZZ' b', Z' MZ' MjZ' {n' xZxn {Z' {aZk' {n'n x'Uj Z{nn{a' k nX jZ'
AaZ'l k UZxn_XMlMyb' l Mjy' yZX'Ut' {aZ' {Miz' k ZMj xZ' yan jX'UZ' jZyy' {aM' 'nx'Zw' Mj' {n' {aZ' k UZxn'_b u {y'VMl'VMjZ'nl 'n x' k b'xnVhl {xnjZx^a'	<ul style="list-style-type: none"> ° a ž ZVhl y{x V{ 'uxZ'Z. by{b' ` {Miz' k ZMj xZ' £ a † aZV' b'Z. by{b' ` XMlMyb' l Mjy'nl ' {Miz' k ZMj xZ' MZ' jZyy' {aM' k UZxn'_ b u {y'nl ' k b'xnVhl {xnjZx'Ut' Vhl l b' ` {aZ' XMlMyb' Zy'

2.7 Schematics

<Zxam'ynl Z'n_{aZ'k nxZ' VaMjZl `b' `uM' {y'n_{aby'uxn'ZV{ by' {aZ' _W{ {aM' {aZxZ' MZ' M' | k UZxn'_ VxV| k'ZjZk Zl {y', ab'va' k | y{ 'UZ' Vhl | ZV{ZX' {n' Z' {aZx'b' Myk Nj' MZM' M' 'M' Z'_nx{ {n'yan, 'an, ' {aZyZ' ZjZk Zl {y' MZ' Vhl | ZV{ZX' {n'nl Z' M'n{aZxS{aZ' y'VaZk M'by' VhxxZyuni Xb' ` {n' Z'Wa'k nX| jZ' VMl 'UZ'_n| | X'UZjn, ^a'

2.7.1 Power Module Schematic

' b | xZ' b'UZjn, 'n| j{b' Zy' {aZ' <n, Zx'2 nX| jZ' @VaZk M' b' Vhl {N' b' ` {aZ' äG'UM{Zxt+S{aZ' j' bXZ' y, k'VaSMIX' {aZ' äG'j' b' Z' M' f'nj{MZ' xZ' | jM'nx^a' AaZ' UM{Zxt' by' | yZX' Mj' {aZ' un, Zx'yn| xVZ' _nx' Mj' n'_

{aZ'NXXZX'ZjZV{xnl bYs{aZ'yjBZ'y, bVa'by'|yZX{n{|xl'nl'MIX'n_un, Zx'n{aZ'NXXZX'ZjZV{xnl bYsMIX{aZ'fnj{MZ'xZ'|jMnx'y{Zuy'Xn, l {aZ'fnj{MZ'jZfZj'_xnk 'aG{n'aG^a

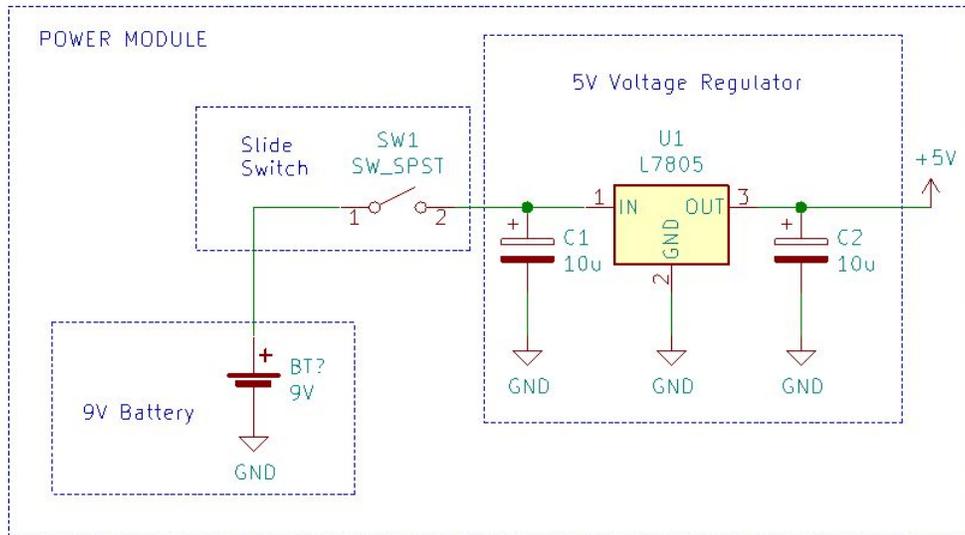


Figure 4. Power Module Schematic

2.7.2 Control Unit Schematic

' b | xZ'a'UZjn, 'n| jB Zy{aZ'nl {xnj'BI b'@vazk Mb'Vnl {Nb b` {aZ'k b'xnvnl {xnjjZxS{aZ'Uj| Z{nn{a'k nX|jZSMIX{aZ'XMIMyb| Mjy'Vnk b`'_xnk {aZ' {Muz'k ZMj| xZ^aAaZ'k b'xnvnl {xnjjZx'yZxfZy'Mj'Mk b'XjZ'k M'UZ{, ZZI {aZ'XMIMyb| Mjy'MIX{aZ'Uj| Z{nn{a'k nX|jZ^2 nxZ'yuZVb'Mj|tS b' b {ZxuxZ'y{aZ'XMIMMnk b`'_xnk {aZ' {Muz'k ZMj| xZSMIX'| yZy{aZ'Uj| Z{nn{a'k nX|jZ'Mj'Mk ZMjy{n'Vnk k | l b'MZ', b'a {aZ'uMkZX'Uj| Z{nn{a'XZ'fVZ^a

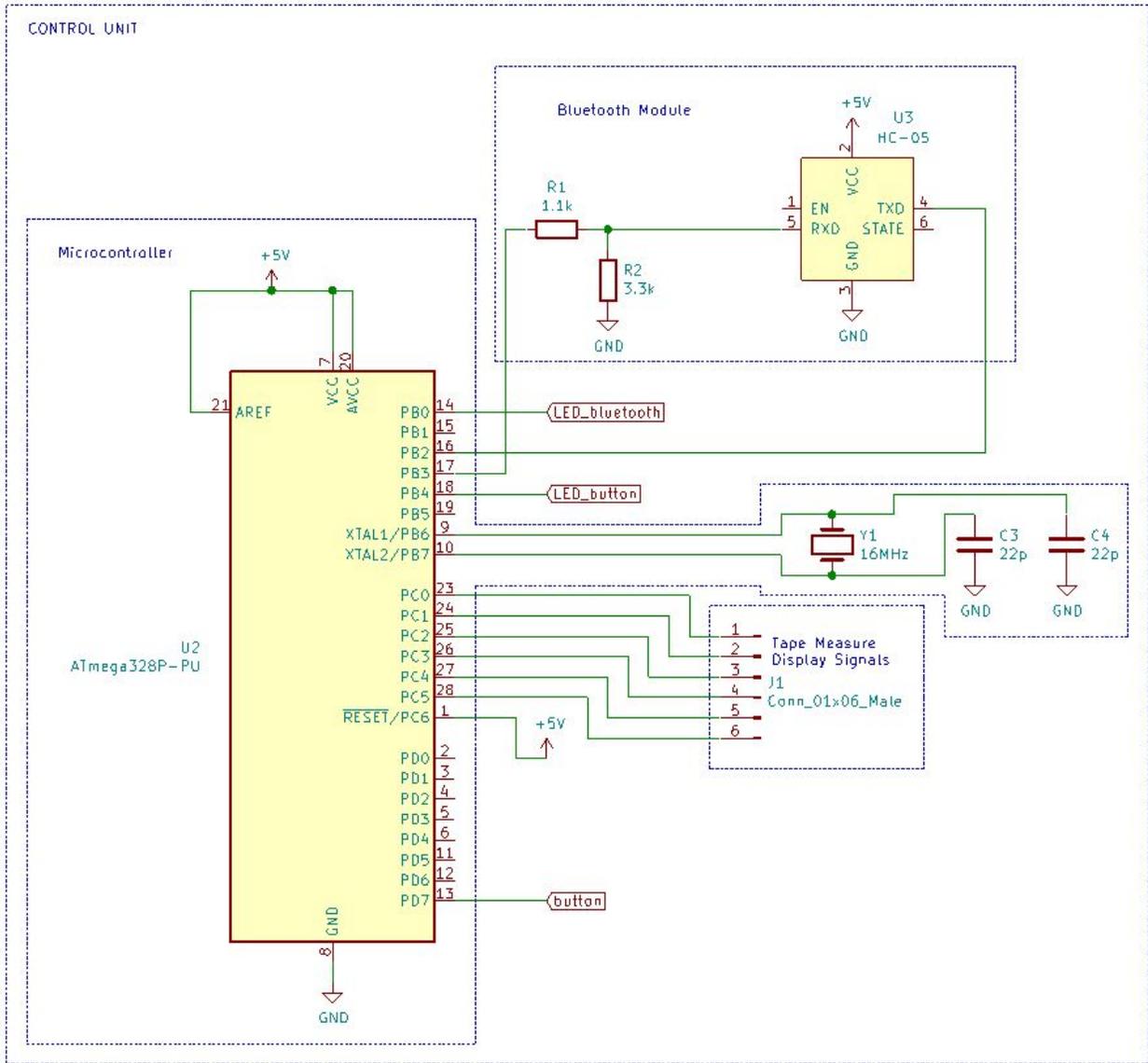


Figure 5. Control Unit Schematic

2.7.3 User Interface Schematic

' b | xZ ' á UZjn, ' n | j b Zy { aZ ' ByZx ' i { Zx ' WZ ' @ / aZk M l v Vnl { N b b ' ' { aZ ' 1 " ž y ' M X { aZ ' U | { { n l ' aA z ' 1 " ž y ' M X ' | yZ X { n ' u x n f b X Z ' f b y | M j b ' n x k M l m l { n { aZ ' | yZ x x Z ' M X b ' ' 5 3 μ 5 ' ' y { M | y ' M X ' U j | Z { n n { a ' Vnl | Z V { b l ' y { M | y ' aA z ' U | { { n l ' , b j ' U Z ' | yZ X { n ' y b l M j { n { aZ ' k b x n Vnl { x n j j Z x , a Z l { n ' y Z l X X M l M { n { aZ ' u M X Z k n U b j Z X Z f b V Z ' a ' 3 n { Z S M j ' n { aZ y Z ' Vnk unl Z l { y ' M Z ' Vnl | Z V { Z X { n ' X b b M j ' u b y ' n { aZ ' ° A 2 " (° b Ÿ ā < ° a

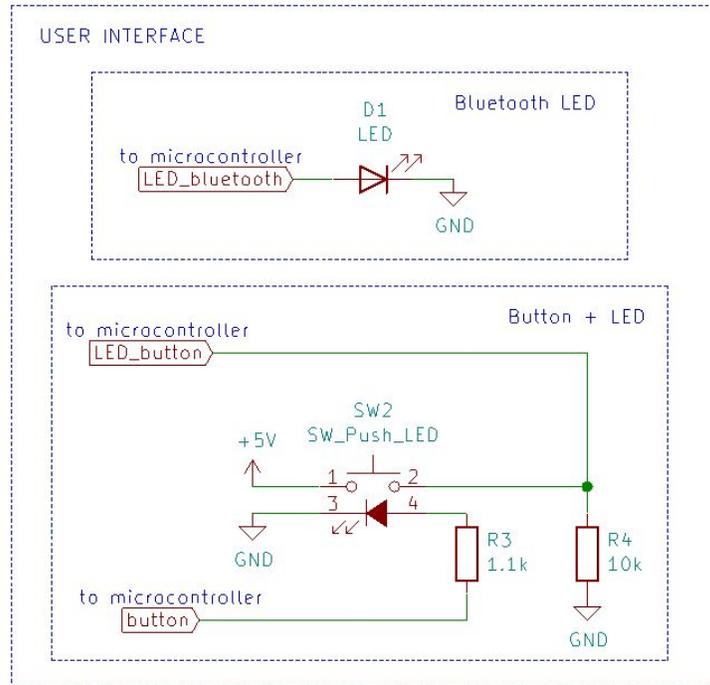


Figure 6. User Interface Schematic

2.8 Software

AaZ`{Muz`k ZNy| xZ`b {ZxW(y, k`a {aZ`k nUjZ`MuujbMl`l {axn|`a {aZ`Uj| Z{nn{a`k nX| jZ`b`n|x` Vnl {xnj}| l k`a` ab`a`jZfZj`nfZxfZ, `n_{a`b`b {ZxW{l`l`b`y`X`byujMZX`b`_b|xZ`B`a`

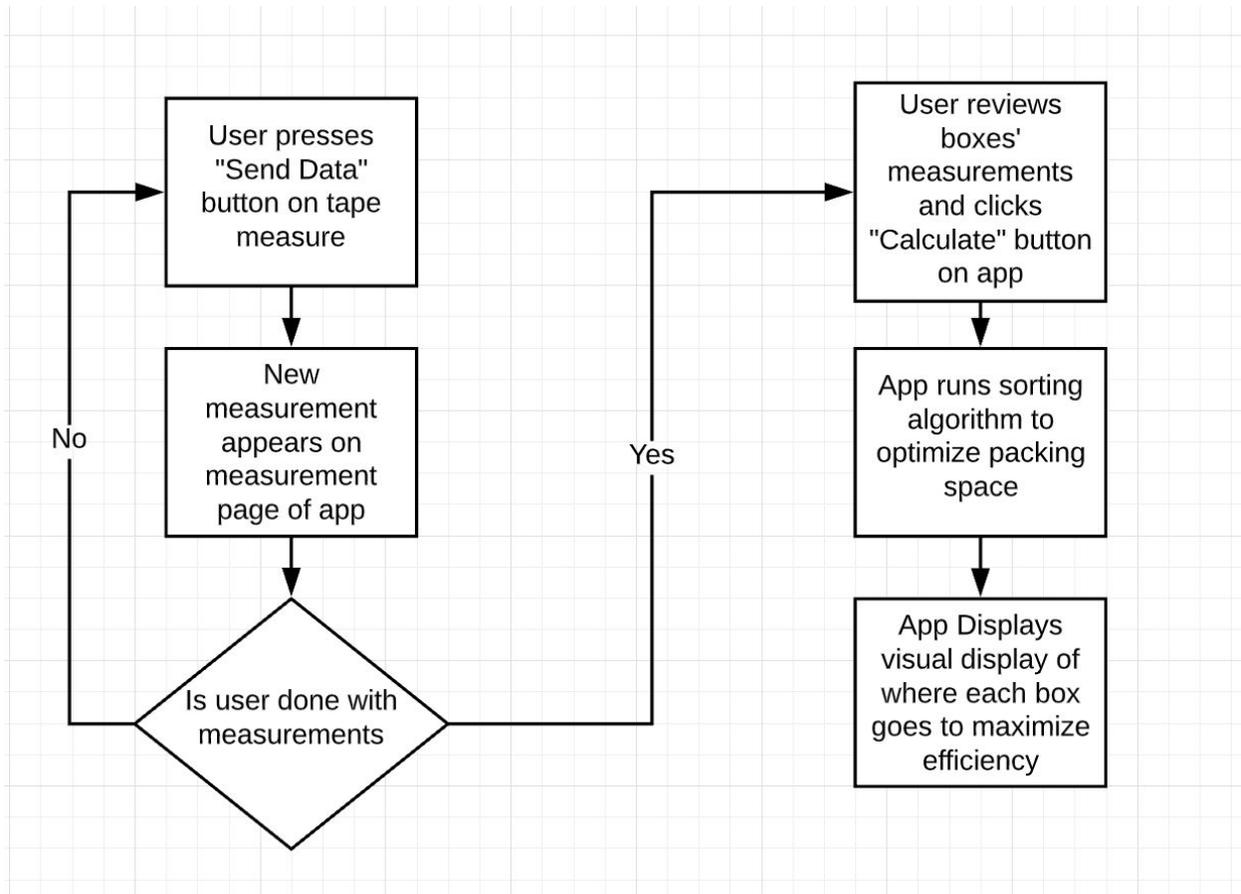


Figure 7. High-level Tape Measure and App Interaction

2.9 Fault Tolerance

<ZxMiy'nl Z'n_{aZ'Ub`Zy{nUy{MjZy', ab/a', bj'UZ'_MZX'b {aby'uxnlZV{ by'XZVnXb` {aZ' k ZMj| xZk ZI {yb| Mjy', ab/a' MZ' yZI {n' {aZ' XbyujM' n_{aZ' {Miz' k ZMj| xZ^aAaZxZ' MZ' k | j{bujZ' xZMj'n| y', at {aby'Vn| jX'UZ' MvaMjZl `Z^a" by{Syb' VZ', Z'aMjZ' l n{tZ{ aMj' {aZ' nuunx{| | b{t' {n' jnni' b' ybXZ' {aZ' {Miz' k ZMj| xZ', Z'ujM' {n' | yZ' {aZ' ZAMizUa' AUPAS{aZxZ' by'Mj'n{ n_| | VZx{Mj' {t', b'a' , aMj'ZjZV{xnl by', Z', bj' _b' X'b' ybXZ^a'H b'a' {aby'UZb' ` yMj'S{an| ` a\$, Z' aMjZ'aMj' {aZ' nuunx{| | b{t' {n' nuZI' | u'MXb_zxZI {Miz' k ZMj| xZ', ab/a' aMj' MXb' b{Mj' XbyujM'S' b' b' ` | y'Mkn| ` a' bXZMh_, aMj' , Z' VM' j'b' Zjt' Z. uZV{ {n' _b' X'b' ybXZ' {aZ' nl Z', Z'anuz' {n' | yZ^a" nx' xZ_zxZI VZSub{| xZ'n_{aby' {Miz' k ZMj| xZ' VM' UZ' _n| | X'b' ` uuZI Xb.: ` j' b| xZy'a' UUA^*1 {aZ' {Miz' k ZMj| xZ', Z', ZxZ' MjZ' {n' XbyMjyZk UjZS, Z'_n| | X' {aZ' XbyujM' by'Vn| | ZV{ZX' {n' {aZ' k Mj' <t' E' fBMVUB' ub' xWUnl' VMjZ' n_ , ab/a' nl jt' a' ub' y'MiuZMj' {n' UZ' | yZX^a' VM' UZ' Mjy| k ZX' {aMj' , n'n_{aZyZ' ub' y'MZ' j'b' Zjt' | yZX' {n'

un, Zx{aZ'XbyujM'jZMf' á'ub'y{n'UZ'|yZX'nx'Vnk k | I bMl'ni 'u| xunyZy'a'1nni b' 'M' wj Ml'ni 'US {aZxZ' MZl -f' k M'f' | k UZxy', ab'va VM 'UZ' xZuxZyZl {ZX'|y' b' 'ni j'f' á' Uq'ý©

....."Ncti gw'F geko cniTgrt gupvc vkpp" ? "4^{%dku} ? 4⁸ ? 86" "w'Ü"

AaZxZ'nxZSb' VM 'UZ' M'y| k ZX'uM'VjZ' Vnk k | I bMl'ni 'by' | n{ {aZ'ux'k M'f' k Z{anX', b'a', ab'va {aZ' ni 'UnM'X'k b'xnVnl {xnjjZx{M'f' y{n {aZ'XbyujM'SU| {xM'aZxSyZxb'Vnk k | I bMl'ni 'k | y{ 'UZ' b' VnxunxM'Z'X'ynk Zan, 'AabyjZM'Xy'b' {n {aZ'yZVnl X'un{Zl {b'Vj'uxnUjZk ©'b' | x'b' 'n| {', ab'va {tuZ' n_yZxb'Vnk k | I bMl'ni 'by' | yZX'aAaZxZ' MZ' k M'f' Vnk k ni 'yZxb'Vnk k | I bMl'ni 'uxn{nVnjy' , ab'va Z' by' {aAaZyZ' b' Vj| XZ' ? @Y'P'Y'S@<'S'f' S'M'X' B' ? AS{n' l' M' Z' M'Z', 'AÜB'Ä' AaZxZ' 'by' | n' ' | M'M' {ZZ'San, ZfZxS{aM' M'f' n_{aZyZ' MZ' | yZX' Ut' {aZ' X'b' b' M'f' {M'Z' k ZM'y| xZ'aAaZxZ'nxZS, Z', b'j' j'b' Zj'f' l' ZZX' {n' uxnUZ' {aZ' b' X'b' b' | M'f' u'b' y'n_{aZ' x'b' U'n' l' VM'jZ' {n' b' | xZ'n' | {an, 'ZM'wa' y'b' l' M'f' b' k uM'W'y{aZ'n' | u| {n' l' {aZ'XbyujM'a'2' nxZ' yuZVb' b' Vj'f' S, Z', b'j' 'UZ' j'nni b' 'M'f' {aZ' y'b' l' M'y' -f'nj{M'Z' jZfZjyS{aZ' M'uM'Zl { 'UM' X'xM'Z' ;XZ{Zxk b' ZX' Ut' " wj Ml'ni 'Y'ASy{M'f' {y{n' u'q' uM'f' Zx' ySM' X' x' M' b' ' uM'f' Zx' y' jZl ' {ay' {n' x't' {n' VaM' M'W'Z'x'Z', ab'va uxn{nVnj' k b'a' { 'UZ' | yZX' UZ', ZZl' {aZ' {M'Z' k ZM'y| xZ' -y' k b'xnVnl {xnjjZx' M' X' b' -y' XbyujM'a' "

....."Dcw'f'Tcv'g ? $\frac{\%uf' o' dqu}{3'ugeqpf}$? $\frac{3}{rgt'kfj}$. "cuumo kpi '*3'dk'r'gt'uf' o' dqu" "w'Y"

5l' Z' b' M'f' Vnl VZx' {n' l' n{ 'aZ'xZ' 'by' {aZ' ua'ty' b' Vj'f' {ZxM'f' l'ni 'UZ', ZZl' {aZ' {M'Z' k ZM'y| xZ' -y' XbyujM' y'b' l' M'y' M'X' {aZ' " A2 " (° P'Y'ä<-y' b' u| {y'a' AaZxZ' 'by' M' nnX' VaM' VZ' {aZ' f'nj{M'Z' {aZ' {M'Z' k ZM'y| xZ' | yZy'nx'Vnk k | I bMl'ni 'by' | n{ 'àG'j'n' b'j' b' Z' {aZ' b' u| {y' {n' {aZ' " A2 " (° P'Y'ä<' a' 5l' Z' uny' b' jZ' , nxi M'n' | l' X'nx' {aby', n| jX'UZ' {n' | yZ' {aZ' M' M'f' n' b' u| {y' n' l' {aZ' " A2 " (° P'Y'ä<' b' y{ZM'X' n_{aZ' X'b' b' M'f' n' l' Zy' M'X' k M'f' {aZ' f'nj{M'Z' xM' ' Z' {n' ynk Z' {ab' ' k nxZ' XZy' b' M'jZ'a' AaZ' by' jZ', b'a' {aby'S an, ZfZxS'b' y'uZx'nxk b' 'M' M' M'f' n' ? ZM'X'Ä' Vnk k M'X' x'nk {aZ' " x' l' b' n' ' l' M'f' n' ' µ5' j' b' x' M'f' 'Ä'Ü'Ä'Ä' {M'Zy' M' M'f' j' y'b' l' b' b' M'f' {M' k n' | l' {n' {b' Z'a' Wnx'X'b' ' {n' 'Ä'Ü'Ä'Ä'Ä' {M'Zy' M' M'f' n' | { 'ÜÜÜ' k b'xn'yZVnl Xy' {n' V'j' M' M'f' n' ? ZM'X'Ä'Ä' VZ'a' @Z'b' ' M'y' {aZ' xZ' k M'UZ' k nxZ' {aM' n' l' Z' y'b' l' M'f', ab'va', n| jX' l' ZZX' {n' UZ' M' M'f' n' %X' S{aZ' {n' {M'f' n' k n' | l' {n' {b' Z' b', n| jX' j'b' Zj'f' {M'Z' {n' M' M'f' n' %Z' l' y'b' l' M'y' by' b' fZl' b' " wj Ml'ni ' p©

....."VqwnTgcf"Vko g ? $\frac{322'' u}{3''iki' pcn}$? "%iki' pcn" "w'P"

AM' b' {aZ' b' fZxyZ'n_{aby'xZy| j' {uxnX| VZy' {aZ' k M' b' k | k 'UM' X'xM'Z' ;M' M' S'M'y| k b' 'Ü' Uq' uZx' ytk Unj'Ä', ab'va {aZ' " A2 " (° P'Y'ä<' Vn| jX' {aZ'nxZ' {b' M'f' f' b' {ZxuxZ' S' b' fZl' b' " wj Ml'ni ' B©

....."O cz'Dcw'f'Tcv'g ? $\frac{3}{VqwnTgcf"Vko g}$? $\frac{3''iki' pcn}{322'' u}$ " "%iki' pcn" "w'B"

* {aZ' Z' fZl' { {aby' y' M' ujb' ' xZw' Zl' Vt' by' -f' wj M' Zl' n' | ' aS' k M'UZ' UZy' {n' x't' M' ujb' f' b' {aZ' y'b' l' M'y' Vnk b' ' xnk {aZ' {M'Z' k ZM'y| xZ' yn' {aZ' t' UZ' Vnk Z' Vnk uM' b' jZ', b'a' {aZ' " A2 " (° P'Y'ä<-y' X'b' b' M'f' b' u| {y', ab'va MZ' Vnl y'XZ'x' M'j'f' ' M'y' {Zx' {aM' {aZ' M' M'f' n' b' u| {y'a' Aaby'San, ZfZxS, n| jX' j'b' Zj'f' "

xZwł bZ {aZ | yZ n_MjZfZj yab{Zx^a1ZfZj yab{Zxy'aMfZ jtk b'y'n l'an, wł b'j t {aZ t'VM UZ'y, b'VaZX^a (Zl ZxMj t'yuZM b` S{an|` aS{aZ_xZwł Zl Vt', b'a', ab/a Xb b'Mj b ul {y'VM y'VM {aZ y'b l Njy» ZfZl` , b'a {aZ'y, b'Vab` jtk b'y'n_{aZ jZfZj yab{Zxy» y{b'j, n|jX'uxn'f'XZ UZ{{Zx'uZx_nxk MlVZ` j b {Zxk y' n_yMk uj b` xMZYA{aM ytk ujt | yb` {aZ'MlM'h` ub y^aAaZxZ_nxZS, Z'yan|jX UZ`MjZ {n'xZMk` y'b l Njy Vnk b` _xnk {aZ {MlZ k ZMj| xZ`_nx'Xb_ZxZl {`fnj{MZ jZfZj y'Ml X'pux'y{Ml X'MX'UM| X'xMZY^a

H b'a Mj {aby'UZ b` y'MXSZfZl b` {aZ', nxy{VMjZ yVZl M'k, aZxZ', Z', n|jX'UZ | l MjZ {n'xZMk XMM` _xnk {aZ {MlZ k ZMj| xZS{aby', n|jX' l n{ l ZVZyM' b' t' UxZM' n' x'uxn'ZV{^aBj{tk MZj tS, Z l ZZX {n` Z{ k ZMj| xZk Zl {X'MlMynk Zan, SMI X' | yb` 'Mk b' Mj {MlZ k ZMj| xZ' b'y'n l Z'n_k Ml t', M'y {n'Xn {aby^a H Z Vn| jX S b' y{ZM S| yZ V'k ZxMjSZl VnXZxySMl X'pux'n{aZx'Xb{MlVZ` yZl ynxy{ n'uZx_nxk {aZ y'Mk Z' {Mj' b' M'k b_ZxZl {, M^aBj{tk MZj tS, Z'UZjZfZ {aZ {MlZ k ZMj| xZ', n|jX'UZ {aZ UZy{`nu{b' l `nx' {aZ Vn l y| k ZxSU| { {aZxZ` MZ` n{aZx'nu{b' l y'n| { {aZxZ', ab/a', Z Vn| jX' | yZ M'y| Uy{b' {Zy' b' n| x' uxnhZV{ b' {aZ ZfZl {, Z' MZ' | l MjZ {n` Z{ {aZ {MlZ k ZMj| xZ' {n', nxi^a

3 Costs

5| x'XZfZjnuk Zl {Vny{y'Vnk Z`_xnk {axZZ'uZnujZ', nxi b` 'UÜ'an| xy'M, ZZi 'M'ÖaÜ'M' an| x'uZx' uZxynl^aAMl b` {aby'fMj| Z`_nx{aZ Üá', ZZi y{aM', Z'MZ', nxi b` n l {aby'uxnhZV{` b'Zy| y'ÖaÜSÜÜ` _xnk " wł M' b' l` a^a

".....5", "&72j qwt", "32"j qwt uly ggm', "38"y ggm', "40"? "&82.222" "w^a

AaZ Vny{ n_n| x'uxn{n{tuZ', b'j UZ` Öáá^aaP^a*_, Z u| xVaMjZ n| x'uMk{y' b' U| j i` j'Ut {aZ ÜÜÜ'uMk{y'Än| x' {n{Mj', b'j UZ` Öáá^aaY^aAaZ UxZMlXn, l n_{aZyZ Vny{y'MZ j b{ZX'UZjn, ^a

<Mk'	† ny{`<xn{n{tuZÄ'	† ny{`< j j i` ÜÜÜ'uMk{y'Ä'
2 b'xnVn l {xnjjZx' j` A2 " (° PÝá<l<B` 1`ž b b ZtÄ	Ó ^a Üá'	Ó ^a aP'
Ýá<b @nVl Z{`ž` ž ÝáÜž A` 1` ž b b ZtÄ	Ó ^a pp'	Ó ^a ÝÝ'
àG`Gnj{MZ`?Z` jM'nx' jB° ááÜat O@` 1`ž b b ZtÄ	Ó ^a aa'	Ó ^a Bá'
ÜÜy' † MlMl{nx`ž.ÝÄž<áÝá`13ž` 1`ž b b ZtÄ	Ó ^a Bá'	Ó ^a Üá'
ÜÜi` ?Zy{y{nx`žÜÜÜ>ŁO`13ž` 1`	Ó ^a ÜÜ'	Ó ^a ÜP'

ž b b ZtÀ		
ÝÝÜ?Zyby(nx'¿.ÝÄ¿ÝÝÜ(ŁO'3ž '1' 1'ž b b ZtÀ	ÓÜaÝÜ	ÓÜaÜa
ÜaÜi ' ?Zyby(nx'¿ÜaÜO>ŁO'3ž '1' ž b b ZtÀ	ÓÜaÜÜ	ÓÜaÜP
PaPi ' ?Zyby(nx'¿PaPO>ŁO'3ž '1' ž b b ZtÀ	ÓÜaÜÜ	ÓÜaÜP
ÝÝü' † MúMú(nx'¿.ÝÄ ¿Paá'ÜaÝá'3ž '1'ž b b ZtÀ	ÓÜaāā	ÓÜaPa
Üá2) %bjnV † xty{Mj' ¿PÜÜ'áÜPß'3ž '1'ž b b ZtÀ	ÓÜaß	ÓÜaPa
< yaU {{nl ' , ká '(xZZI '1" ž ' ¿BaÜ'Ýáāā'3ž '1'ž b b ZtÀ	ÓāÜÜ	ÓāÜP
Łj Z'1" ž ' ¿' áÜPŁ'ŁŁ 3 † GÜLÜBaÜ'3ž '1' ž b b ZtÀ	ÓÜaÝÜ	ÓÜaÜa
@bXZ'@ kVa ¿ 03ÜÜááá'3ž '1' ž b b ZtÀ	ÓāaÝ	Óßaß
äG'ŁM{Zxt'¿' k Mßd 'ŁMßyÄ	ÓPaBa	ÓÜaÝ
Łj Z{nn{a'2 nX jZ'¿) † 'Üa'1' yMUMI'` nnX^vnk Ä	ÓāÜP	ÓāÜP
ž b kMj'AMúZ'2 ZMj xZ' ¿ZAMúZÜa' " AÜáaā'1XU'?' <'1' Mk Mßd ^vnk Ä	ÓÝaāā	ÓÝaāā
<Ł Ł ¿<Ł ŁH MÄ	Óā	ÓÜaÜa
† Mj' ` ¿Pž 'uxb { 'Zy{tk MZÄ	ÓP	ÓP
5{aZx?Zyby(nxySAXMjyby(nxyS MIX'(ZI ZxMj" jZV{xMj' † nk unl ZI {y¿ž b b Zt' Zy{tk MZÄ	ÓÜÜ	ÓÜaÜ
An{Mj'† ny{	ÓāāaP	ÓāāaÝ

4 Schedule

H ZZi	3MaM lzj	A/	LNWa
' ZU ^a ÝBSÝÜYÜ	AMj , b'a k Wab Z yanu Mln xZVnk k ZI XMlbnl y_nx uatybMjXZyb l ^a @ Uk b'nxXZx_nx{MIZ k ZNy xZ M X b b'bj Vnk unl ZI {y ^a	?ZyZMVA <MI b` <xnUjZk ` j` nxbak y l` ujM {aZ Vnny ujM_nxk` Mdu`nl` Gby Mj@ Xbn`	?ZyZMVA b'z` fby Mj b {Zx_MZyMIX` y{x V{ xZy{n`Zk UZX` _nx`k nUljZ` MdujbMlbnl` XZfZjnuk ZI {a ^a
2 M ^a ÝSÝÜYÜ	5I VZ {MIZ k ZNy xZ by xZVZbZXSUZ` b` _b xb` n {an, yb l Mj {n {aZ XbyujM` , nxi ^a	ŁZ` b` Vnl I ZV{b` {aZ` Mdu`n Uj Z{nn{a M X` XbyujM b` {n {aZ yZx` b {aZ uanl Z` by` Vnl I ZV{ZX {n {aZ` Uj Z{nn{a` k nX jZ ^a	ŁZ` b` Vnl y{x V{bnl` MIX XZyb l` n`_b'z` k nXZj Mj nxbak` UMyZX`nl` b'Zl` xZy j{y`_xnk` jynx{b` Mj nxbak`
2 M ^a aSÝÜYÜ	' b MjZujM`_nx` VnjZV{b` `yb l Mj` _xnk` {aZ XbyujM S nxXZxZ. {xMuM{yMj` I ZZXZX ^a @ Uk b` uxnunymj_nxXZx_nx` <Ł Ł ^a	H nxi`nl` {aZ`uMZ` , aZxZ` {aZ` k ZNy xZk ZI {fMj Zy` , b'j`UZ`NXXZX`MIX` Mjn, {aZ` yZx`{n` b u {fMj Zy` k M Mj t` M X`y{M{` `Z{{b` k ZNy xZk ZI {y`_xnk` Uj Z{nn{a` k nX jZ ^a	<xn` xM` Uj Z{nn{a` k nX jZ`{n`yZl` X` b` Vnk b` `XMIM_xnk` {aZ` k b'xnVnl {xnjjZxp{MIZ` k ZNy xZ` Vnk Ub` Mlbnl` {n`n x` k nUljZ` MdujbMlbnl` , aZl` @Zl` X`z` MIM Uj {{nl` by`uxZyyZX ^a " I y xZ` Mj` XMIMby` UZb` `yZl` {n`fZx`_xnk` k nX jZ`{n`k nUljZ` Mdu ^a
2 M ^a ÜaSÝÜYÜ	Axt`{n`b` VnxunxMZ` k b'xnVnl {xnjjZx`{n` xZNX`XMIM_xnk` XbyujM ^a	Ł nl` {b Z` Z{{b` k ZNy xZk ZI {y`_xnk` {MIZ`k ZNy xZ` M X` yMfZ` {aZyZ` fMj Zy`b` Łn..VjMy, abZ` uMxyb` M X`k Ml b` y xZ` {aZ` b u {y`MZ` Xn UjZy ^a jyn`y{M{` Mj nxbak` ^a	ŁZ` b` NXXb` Vnyk Z{b' ZMl xZy`{n` {aZ`k nUljZ` MdujbMlbnl` j'b Z` jMUZjb` S b` fZl` {nxt`S MIX`VjMybMlbnl` n` b'Zk y ^a ByZxy`VM jMUZj` {aZbx`Un. Zy`MIX` yuZVb t` b` {aZ t` MZ` j'b a {SaZMf t` S_xMljZS

			Z{V ^a AaZ† VMi Mjyn {MIZ' b fZI {nxt' n_ , aM' bZk y' MZ' b' Z' N' Wa Un. . .
2 M ^a YpŠYŮYŮ	@jXZxVnk unl ZI {y' nl {n' <† t ^a	† nl {b Z {n', nxi' nl' {aZ' Mj' nxbak' {aM' VMi' ujMwZ' {aZ' Un. Zy' b' Pž' MxM'	† xZMZ' l n{bMl' b' b {Zx MWZy' nx yZxy' , aZl' {aZ' Mj' nxbak' by' Vnk ujZ{ZSyn' {aZ†' VMi' fZ, unyybJZ' ynj {bni y ^a ° XXb' ni Mj†' VxMZ' M ank Z' B* nx' k nUbZ' MujbMl' bni ^a
2 M ^a PŮŠYŮYŮ	ž Zyò Z. {Zxnx' Vnyb' ` nx {Miz' k ZMy xZ ^a	H nxi' nl' {aZ' Un. . . XbyujM' uMZ' M' X' VxMz' Pž' k MZ'	tZ' b' {Zy{b' ` n_{aZ' ynx{b' ` Mj' nxbak' M' X' Pž' k nXZj Mj' nxbak' , b'a' {aZ' Uj Z {nn{a' k nX jZ'
° ux ^a áŠYŮYŮ	° yyZk UjZ' {Miz' k ZMy xZ' M' X' k MZ' k nXbMl' bni y' My' l ZZXZx ^a	† nl {b Z', nxi' b' ` nl' {aZ' XbyujM' uMZ'	BuXMZ' M' X' xZ' b' Z' Mj' nxbak' UMyZx' n_ n_{Zy{b' ` xZy j{y' M' X' M' Mj† yby'
° ux ^a ÜpŠYŮYŮ	ž Zyò 'M' X† M' Va' u' , ZZi'	ž Zyò 'M' X† M' Va' u' , ZZi'	ž Zyò 'M' X† M' Va' u' , ZZi'
° ux ^a YŮŠYŮYŮ	ž Zyò 'M' X† M' Va' u' , ZZi'	ž Zyò 'M' X† M' Va' u' , ZZi'	ž Zyò 'M' X† M' Va' u' , ZZi'
° ux ^a YaŠYŮYŮ	ž Zk n'	ž Zk n'	ž Zk n'
2 M' BŠYŮYŮ	<xZyZl {Ml' bni	<xZyZl {Ml' bni	<xZyZl {Ml' bni

5 Safety and Ethics

AaZxZ' MZ' MZ, yMZ{† M' XZ{abMj' Vnl VZxl y{aM' xZy' XZ', b'a' n | x' uxn' hZV{^a 5l Z' n_{aZ' k M' yMZ{† Vnl VZxl y' Vnk Zy' xnk' {aZ' j' b' a' b' k' b' ni U' M{ZxZy | yZX' Ut' n | xXb' b' Mj' {Miz' k ZMy | xZ^a AaZyZ' U' M{ZxZy' VMi' Z. ujnXZ' b' {aZ†' UZVnk Z' n' fZxVaM' XZ' nx' xZ' N' Wa' M' i' Z. {xZk Z' aZM' {Zk uZxM | xZ' ÁÁ' ° XXb' ni Mj†' S{aZyZ' U' M{ZxZy' yan | jX' l n{ 'UZ' VaM' XZ' b' Z. {xZk Z' VnjX' {Zk uZxM | xZyZ' b'aZx' My' {aZ†' VMi' XZ{ZxnxMz' M' X' jZM' VaZk' b' Mj' M' X' ÁÁ' An' Zl' y | xZ' yMZ{† S, Z', b' j' N' XZw' MZj†' {Zy' M' X'

k nI {nX' {aZ' UM {Zxt' VZj {Zk uZxM | xZ {n' ZI y | xZ {y'n' fZxMj' w' Nj' t' M' X' uZx' nX' M' VZ' _njjn, b'` {aZ' | bXZj b' Zy' n' {b' {aby' UM {Zxt' jM' y' MZ {t' | bXZ' AUUA'`

° I n {aZ' x' y' MZ {t' Vnl VZxl' y' {Zk y' _xnk' {aZ' ZI' VjnyZX' Uj | Z {nn {a' k' nX | jZ' M' {M' WaZX' nI {n' {aZ' Xb' {Mj' {M' Z' k' ZMj' | xZ' a' @b' VZ' {aZ' {M' Z' k' ZMj' | xZ' VM' UZ' | yZX' b' Un {a' b' Xnnx' M' X' n' | {Xnnx' ZI' fbnI' k' ZI' {yS' {aZ' Uj | Z {nn {a' k' nX | jZ' yan | jX' UZ' ZI' VM' yZX' b' k' MZ' x' b' j' b' y' Va' M' M' I' n' k' nby' | xZ' nX', MZ' x' VM' yanx' {aZ' Vbx' | b' a' nX' n' | x' yuZ' Vb' b' M' bnI' S {aZ' VM' yb' ` k' MZ' x' b' j' , b' j' N' KaZ' X' {n' * < aá y' M' X' M' X' y' ZI' y' | x' b' ` b' , b' j' , b' ay' M' X' | u' {n' U' k' Z' Z' x' n' , MZ' x' _njjn, b' ` {aZ' | bXZj b' Zy' n' {aZ' * ` xZy' < xn {ZV {bnI' y' M' X' M' X' AUUA'`

AaZ' Uj | Z {nn {a' k' nX | jZ' {yZj' _Njyn' x' M' y' Zy' M' y' MZ {t' Vnl VZxl' X | Z {n' {aZ' Z' .uny | xZ' n' , bXZy' {aM' {aZ' k' nX | jZ' VM' xZy' a' . .unyZX' , bXZy' VM' yZy' by | Zy' _nx' Un {a' {aZ' | yZx' M' X' {aZ' XZ' f' b' Z' b' yZj' a' nX' {aZ' XZ' f' b' Z' S {aZ' Z' .unyZX' , bXZy' VM' UZ' XNk' MZ' X' M' X' pnx' yanx' {Vbx' | b' Z' X' {axn | ` a' M' f' MZ {t' n' k' ZMj' b' Vj | Xb' ` a | k' M' b' X | VZ' a') n , ZfZxS {aZ' Ub' ` Zx' y' MZ {t' by | Z' Vnk' Zy' _xnk' {aZ' | yZx' ZI' X' M' y' Z' .unyZX' , bXZy' VM' VM' yZ' a' M' k' {n' {aZ' | yZx' | yb' ` {aZ' XZ' f' b' Z' a' jZV {x' b' M' j' yanV' y' M' X' U | xI' y' MZ' h' y' ynk' Z' n' {aZ' XNk' MZ' {aM' | yZxy' VM' xZVZ' b' Z' X | Z {n' {aZ' b' {Zx' M' {bnI' _xnk' Z' .unyZX' , bXZy' a' n' N' X' xZy' {aby' y' MZ {t' by | ZS, Z' , b' j' _by' {ZI' y' | xZ' {aZ' VnxxZV' {M' n | I {n' _fnj {MZ' M' X' V | xxZI' {b' j' _jn, b' ` {axn | ` a' Z' M' a' ZjZV {x' b' M' j' Vnk' unI' ZI' {b' n' | x' Uj | Z {nn {a' k' nX | jZ' U' t' ux' n' Ub' ` Z' M' a' u' M' k' M' X' fZ' x' b' t' b' ` b' , b' a' n' | x' xZw' b' Zk' ZI' {y' a' 3Z. {S, Z' , b' j' {aZI' b' y' | jMZ' {aZ' , bXZy' {n' uxZ' fZI' {M' I' t' n' {aZk' _xnk' UZ' b' ` Z' .unyZX' {n' {aZ' | yZx' a' H' Z' u' j' M' nI' b' y' | jM' b' ` {aZ' , bXZy' | yb' ` ZjZV {x' b' M' j' nX' {aZ' x' k' M' j' b' y' | jM' b' ` {M' Z' nI' n' | x' , bXZy' a' n' ZI' y' | xZ' {aZ' {M' Z' a' M' y' MZ' b' b' f' Z' yZ' M' nI' {aZ' , bXZyS, Z' , b' j' {Zy' {M' X' k' MZ' y' | xZ' b' XnZy' I' n' {Vnl X | V' {M' I' t' ZjZV {x' b' M' j' M' y' , Zj' M' y' aZ' M' | u' a' H' Z' , b' j' {Zy' {U' t' _njjn, b' ` {aZ' y' | XZI' {k' M | M' j' _nx' ZjZV {x' b' M' j' y' MZ {t' AUUA'`

° I Z' {ab' M' j' Vnl VZxl' n' | x' uxn' ZV' x' M' y' Zy' b' fnj' fZy' {aZ' Vnl {M' k' ZI' {n' _ux' b' MZ' | yZx' X' M' M' H' b' ab' n' | x' k' n' UjZ' M' u' j' b' M' bnI' S | yZxy' , b' j' UZ' M' UjZ' {n' y' {nxZ' {aZ' b' n' , I' ux' b' MZ' X' M' M' {aM' y' i' Zu' {ab' XZI' _xnk' n' {aZ' x' | yZxy' a' ab' y' by | Z' x' M' y' Zy' {aZ' Vnl VZxl' n' _uny' y' UjZ' X' M' M' Z' M' y' n' x' u' b' M' t' {aM' VM' {MZ' u' j' MZ' {axn | ` a' k' M' j' b' n' | y' n' _f' , MZ' M' {M' y' _nV | yZx' nI' M' u' n' x' u' anI' Z' X' M' M' AaZyZ' by | Zy' ` n' M' M' b' y' {aZ' * * * ` t' nXZ' n' _f' {ab' y' @a' ` I' n' M' f' n' b' b' h' x' b' ` n' {aZ' xyS {aZ' b' ux' nuZ' x' t' S' xZu' | M' bnI' S' n' x' Zk' u' j' n' t' k' ZI' {U' t' _NjyZ' n' x' k' Nj' b' n' | y' N' k' bnI' Aa' An' k' b' b' MZ' {aby' by | ZS, Z' , b' j' a' MZ' M' n' {b' b' M' bnI' M' u' Z' M' {n' | yZxy' xZVnk' k' ZI' Xb' ` unu | j' M' y' ZV | x' b' t' M' u' j' b' M' bnI' y' {n' b' y' M' j' b' {aZ' t' MZ' I' n' {b' y' M' j' Z' X' Nj' k' N' X' t' a'`

@b' VZ' {aZ' k' n' UjZ' M' u' j' b' M' bnI' V' Nj' M' j' MZy' {aZ' I' Z' Z' XZ' X' Nk' n | I {n' _yu' MZ' {n' anj' X' nI' Z' y' UZ' jnI' ` b' ` yS' n' | x' uxn' ZV' {x' M' y' Zy' Vnl VZxl' n' _f' M' b' ` N' k' f' M' {MZ' n' {aZ' ` b' ZI' k' ZMj' | xZk' ZI' {X' M' M' M' X' y' | ` Zy' {b' ` {aZ' Ub' ` Zy' {y' b' % {x' | V' i' uny' y' UjZ' a' Aab' y' Vnl VZxl' f' bnj' MZy' {aZ' * * * ` t' nXZ' n' _f' {ab' y' @P' ` I' n' UZ' anI' Zy' {M' X' xZ' Nj' b' {b' b' y' M' b' ` V' Nj' k' y' n' x' Zy' {b' MZy' U' M' y' Z' X' nI' M' f' n' M' UjZ' X' M' M' Aa' An' M' f' n' b' f' bnj' M' bnI' S, Z' , M' {n' Vnl y' {x' | V' {M' X' XZ' fZ' jnu' M' M' j' n' x' b' ak' {aM' XnZy' I' n' {h' y' Zy' {b' MZ' {aZ' yu' MZ' _xnk' {aZ' ` b' ZI' | yZx' k' ZMj' | xZk' ZI' {X' M' M' S' U | {nI' Z' {aM' V' Nj' M' j' MZy' {aZ' ZI' {bX' X' M' M' y' Z' {M' X' Vnl Vj | XZy' M' {n' M' j' Nk' n | I {n' _yu' MZ' I' Z' Z' XZ' X' _nx' {aZ' | yZx' a' X' X' b' bnI' Nj' t' S {aby' k' ZMj' y' {aM' {aZ' X' M' M' xZVZ' b' Z' X' _xnk' {aZ' uxZ' I' . by' {b' ` {M' Z' k' ZMj' | xZ' k' | y' {UZ' M' V | x' MZ' M' X' uxZ' V' yZ' , aZI' yZI' {n' fZ' x' Uj | Z {nn {a' Vnl I' ZV {bnI' a'`

?Z_ZxZI VZy©

ÁÜÄ! a) njk ZyS-YÜÜä @MymIX" W(y'n_{aZ" k ZxbMI '2 nfZxS® 2 nfZhx' SÜb'2 M'YÜÜä^a
Á5I jß ZÄ" fMjMjZ© a{{uy@µ, . , . k nfZhx' µk nfb ` 'y(My' _W(yµ' Á WZyyZX©Üä' ZU'YÜYÜÄ'

ÁYÄ-<nu|jMl " W(yS® BI kZX'3Ml y<nu|jMl ž bfybl Sfnj^aàSl n^aYÜÜäSuu^aÜ° àŞZ ZV'YÜÜä^a

ÁÄ@ž, tZxS-Jn| x'2 nfZ @k ujbZX©AaZ'ä ŁZy{ " uuy_nx'2 nfb ` S®? @ ZXWgÜY' / | j'YÜÜä^a
Á5I jß ZÄ" fMjMjZ©

a{{uy@µxk ZXWgMnk µYÜÜäµÜäµÜYµtn| x'k nfZ'yk ujbZX'ä'UZy{ 'Muy'k nfb ` µ'Á WZyyZX©
Üä' ZU'YÜYÜÄ'

ÁBÄ^a (xZZI S-) n, '2 | Va ž nZy'ž' ny('An') bZ'2 nfZxy' 't nk ujZ(Z (| bZS® 2 t'2 nfb ` ?ZfZ, yS
Üä'3nf'YÜÜä^a Á5I jß ZÄ" fMjMjZ©

a{{uy@µ, . , . k tk nfb ` xZfZ, yVnk µk nfZµan, 'k | Va'XnZy'k'Vny{ 'n'abZ'k nfZxyµ'Á WZyyZX©
Üä' ZU'YÜYÜÄ'

ÁÄUM(Zxt| | bZxyk' tVnk S-1káb k 'lml @MZ{t' t' nI VZxI yS® 1káb k 'lml @MZ{t' t' nI VZxI y° ŁM(Zxt'
BI bZxyk' Á5I jß ZÄ" fMjMjZ©

a{{uy@µUM(Zxt| | bZxyk' tVnk µjZMI µVabZyjáb k 'lml ½MZ{t' ½nI VZxI y^a Á WZyyZX©
Üä' ZU'YÜYÜÄ'

ÁÄ*ZZZ^anx' SÉ" " " * " " ' t nXZ 'n_ " {abYÉS'YÜÜä^a Á5I jß ZÄ" fMjMjZ©

a{{u@µ, . , . kZZZ^anx' µMn| {µVnxunxMZµ' nfZxI MI VZµá'á^aa{k j^a Á WZyyZX©Üb' ZU'YÜYÜÄ'

ÁÄ^a a) Mxys-ŁZy{ ž b kN'AMIZ'2 ZMj| xZy'YÜYÜ' ?ZfZ, yI 'Anu' <bl yS®) ZN(tat) MIXtk MIS

Üä' M'YÜYÜÄ^a Á5I jß ZÄ" fMjMjZ© a{{uy@µaZNj{ataMIXtk M'Vnk µUZy{ 'Xb kNj{MIZ'k ZMj| xZyµ'
Á WZyyZX©Üä' ZU'YÜYÜÄ'

ÁÄ- xX| b n'EA'ž| Z{nn{aS® ° xX| b n' Á5I jß ZÄ" fMjMjZ©

a{{uy@µ, . , . kX| b n'WµZI µ2 M µ' xX| b n' nMXŁA¥_xnk ø2 M^a xX| b n' nMXŁ| Z{nn{a^a
Á WZyyZX©ÜÜ' ZU'YÜYÜÄ'

ÁÄ-H AÜÜb° ž ° A° @ " " AS® qjVhI 'IMYSÜä' ZU'YÜÜä^a Á5I jß ZÄ" fMjMjZ©

a{{uy@µ, . , . yjM'Vnk µXnV| k ZI {yµ| UjbµXMMyaZZ{yµH AÜÜb° 'ž MIMaZZ{aX_á^a WZyyZX©
ÜÜ' ZU'YÜYÜÄ'

ÁÚÛÄ-ž b7b7bnl 'n_?ZyZMVA'@MZ{tS®*j7b nbyªÁ5I j7b ZÄª° fN7M7JZ©
a{{uy@µXxyª7b nbyªZX| µkMZµ@MZ{t1b7xM7tµkM7(Zxt@MZ{tªª WZyyZX©ÝP' ZU'ÝÜÝÜÄª

ÁÚÛÄ-ª `xZyy<xn{ZV{bnl ì `*ªAZy{b `©3A©S®3M7bnl M7IAZVal bM7'@ty{Zk yªÁ5I j7b ZÄª° fN7M7JZ©
a{{uy@µ . . .ª {yªVnk µyZxfbZyµ{Zy{b `µZI fbnl k ZI {N7µb `xZyy'uxn{ZV{bnl µªª WZyyZX©
ÝP' ZU'ÝÜÝÜÄª

ÁÚÛÄ-" jZV{x7M7'@MZ{tª@MZ{tì) ZM7(a'nx" jZV{x7M7'AxM7Zy;@| XZI {2 M7| N7AS®ZjVhyaªÁ5I j7b ZÄª°
° fN7M7JZ©a{{u@µ . . .ªZjVhyaªnx µXnV| k ZI {µÜáÝBµäÜµXÜÜÜàBµµyZV{bnl àªª{k jªª WZyyZX©
ÝP' ZU'ÝÜÝÜÄª

ÁÚPÄZAM7ZÜBªÁ5I j7b ZÄª° fN7M7JZ©a{{uy@µZ{M7ZÜªªVnk µyanµµZ{M7ZÜªªXb 7M7'7{M7Zªk ZM7| xZµª
ª WZyyZX©ÝÜ' ZU'ÝÜÝÜÄª

ÁÚBÄªª<M7x7M7 §-@x7M7'<xn{nVh7y7 nk uM7ZX§ªZk UZXXZXªVnk §PÜ'2 M7'ÝÜÜÝªªÁ5I j7b ZÄª° fN7M7JZ©
a{{uy@µ . . .ªZk UZXXZXªVnk µyZx7M7'uxn{nVh7y7Vnk uM7ZXµªª WZyyZX©Ýªª' ZU'ÝÜÝÜÄª

ÁÚªÄ-M7N7h`?ZM7;AS®ªx7| b7nSªª@Zu'ÝÜÜªªªÁ5I j7b ZÄª° fN7M7JZ©
a{{uy@µ . . .ªM7X| b nªWµxZ_ZxZI VZµZI µ7M7' | M7Zµ| | V{bnl yµM7N7h`'7µµM7N7h` xZM7µªª WZyyZX©
Ýªª' ZU'ÝÜÝÜÄª

° uuZI Xb.: © ž b kMj'AMUZ'2 ZMyl xZ''' .Mk ujZ'



Figure 8. Digital Laser Tape Measure

