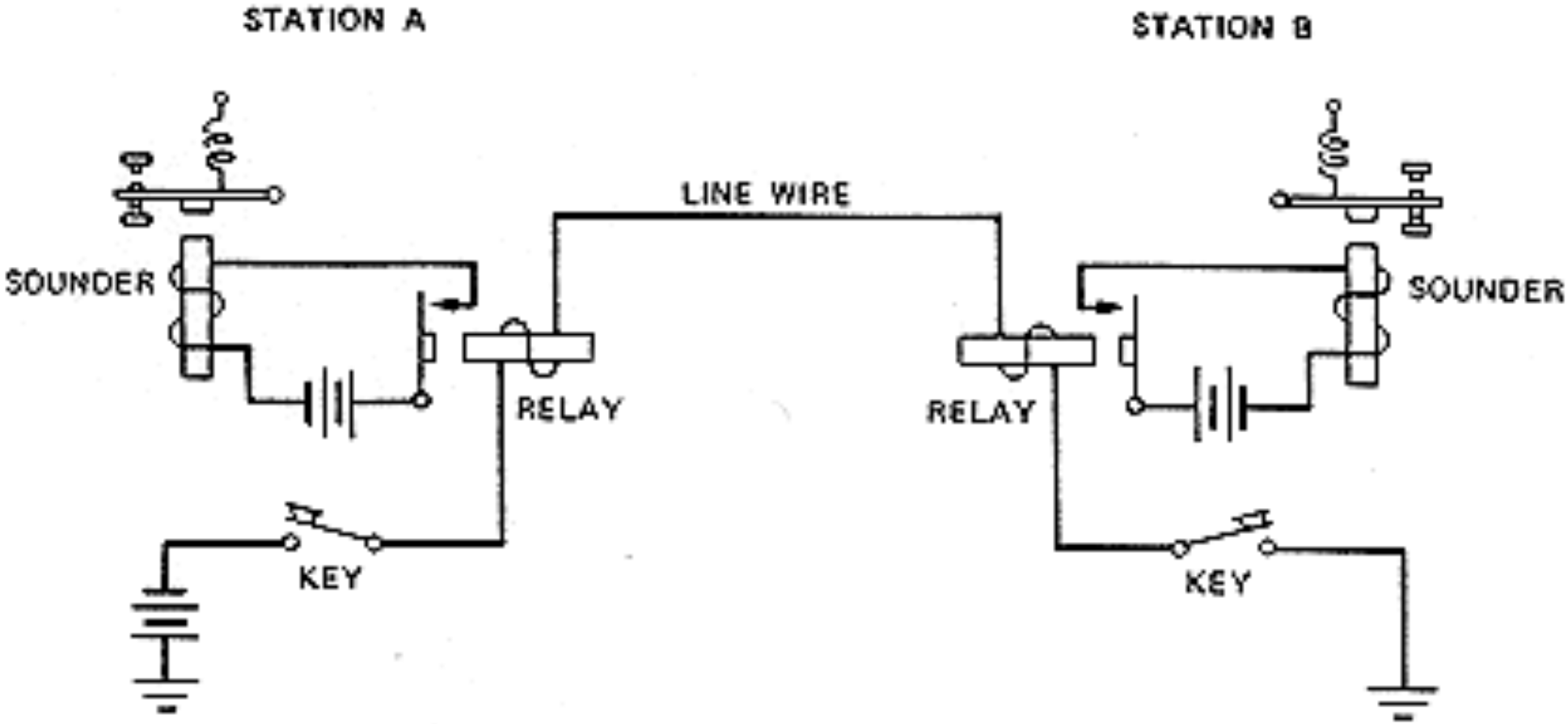
Communication

The Serial Protocol
and
ASCII Character Codes

SIMPLEX TELEGRAPH

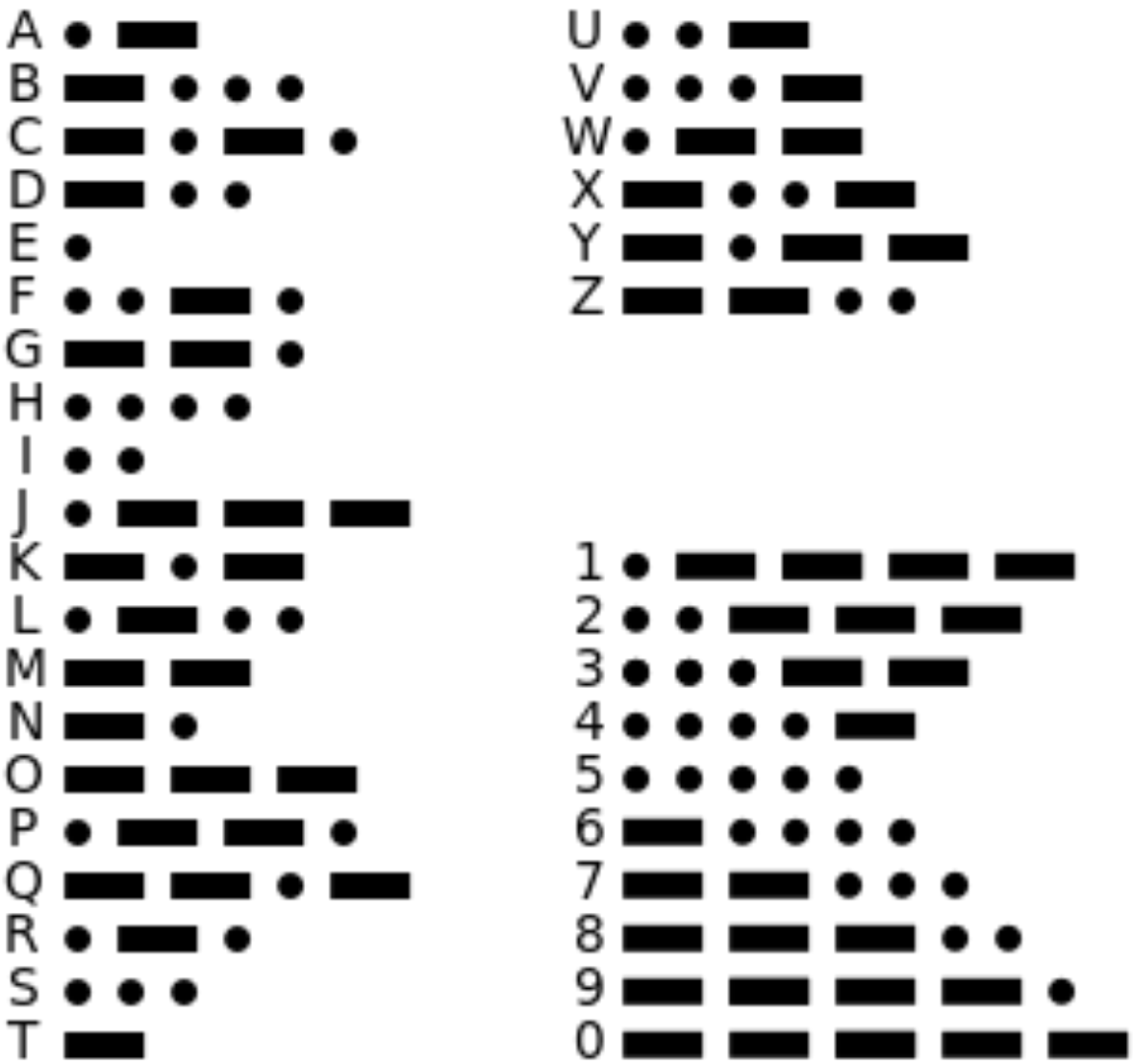


Elementary neutral telegraph circuit.

http://people.seas.harvard.edu/~jones/cscie129/nu_lectures/lecture5/elecmag_tel/morse_tel.html

International Morse Code

1. The length of a dot is one unit.
2. A dash is three units.
3. The space between parts of the same letter is one unit.
4. The space between letters is three units.
5. The space between words is seven units.

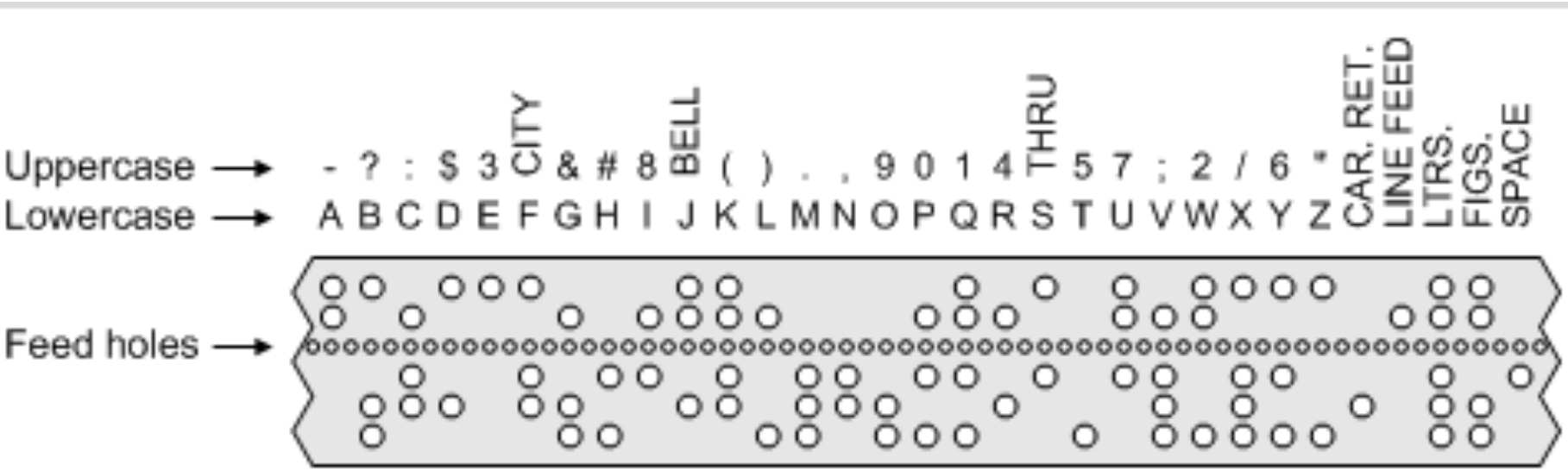


sos.c

Teletype

http://www.smecc.org/police_-__fire_-_civil_defense_communications.htm

Baudot Code



Paper tape showing the five-bit Baudot Code

Baud: Number of symbols per second

https://savzen.wordpress.com/tag/baudot/

```
% ascii
   2 3 4 5 6 7
 ------------
0:   0 @ P ' p
1: ! 1 A Q a q
2: " 2 B R b r
3: # 3 C S c s
4: $ 4 D T d t
5: % 5 E U e u
6: & 6 F V f v
7: ' 7 G W g w
8: ( 8 H X h x
9: ) 9 I Y i y
A: * : J Z j z
B: + ; K [ k {
C: , < L \ l |
D: - = M ] m }
E: . > N ^ n ~
F: / ? O _ o DEL
```

0x30 = ‘0’

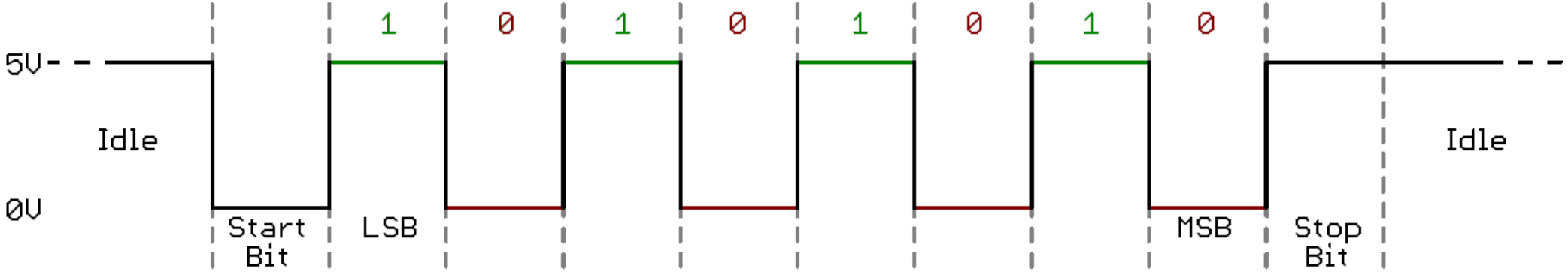
0x31 = ‘1’

0x40 = ‘@‘

0x41 = ‘A’

Asynchronous Serial Communication

(implicit clock)



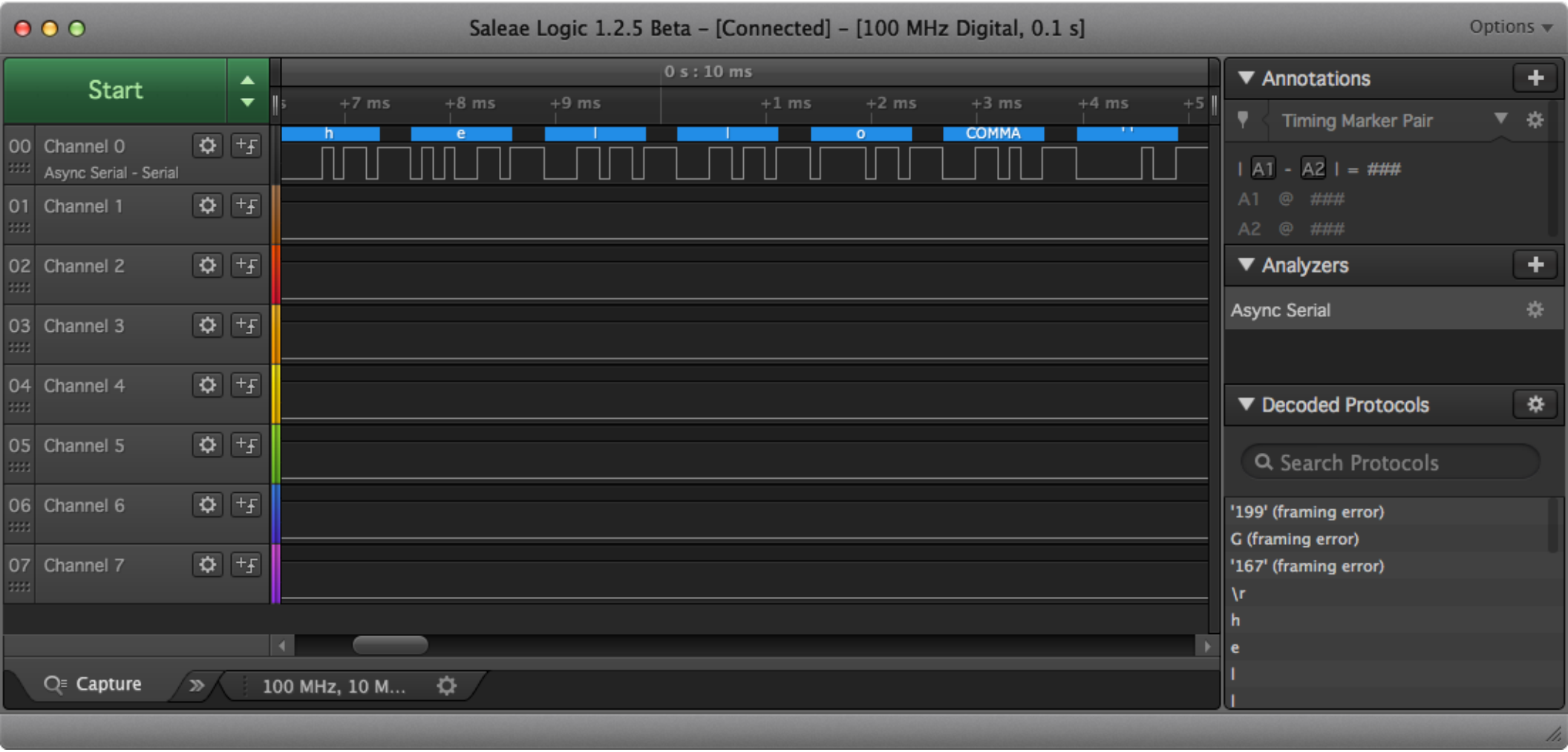
1 start bit (0), 8-bits (data), 1 stop bit (1)

9600 baud = 9600 bits/sec

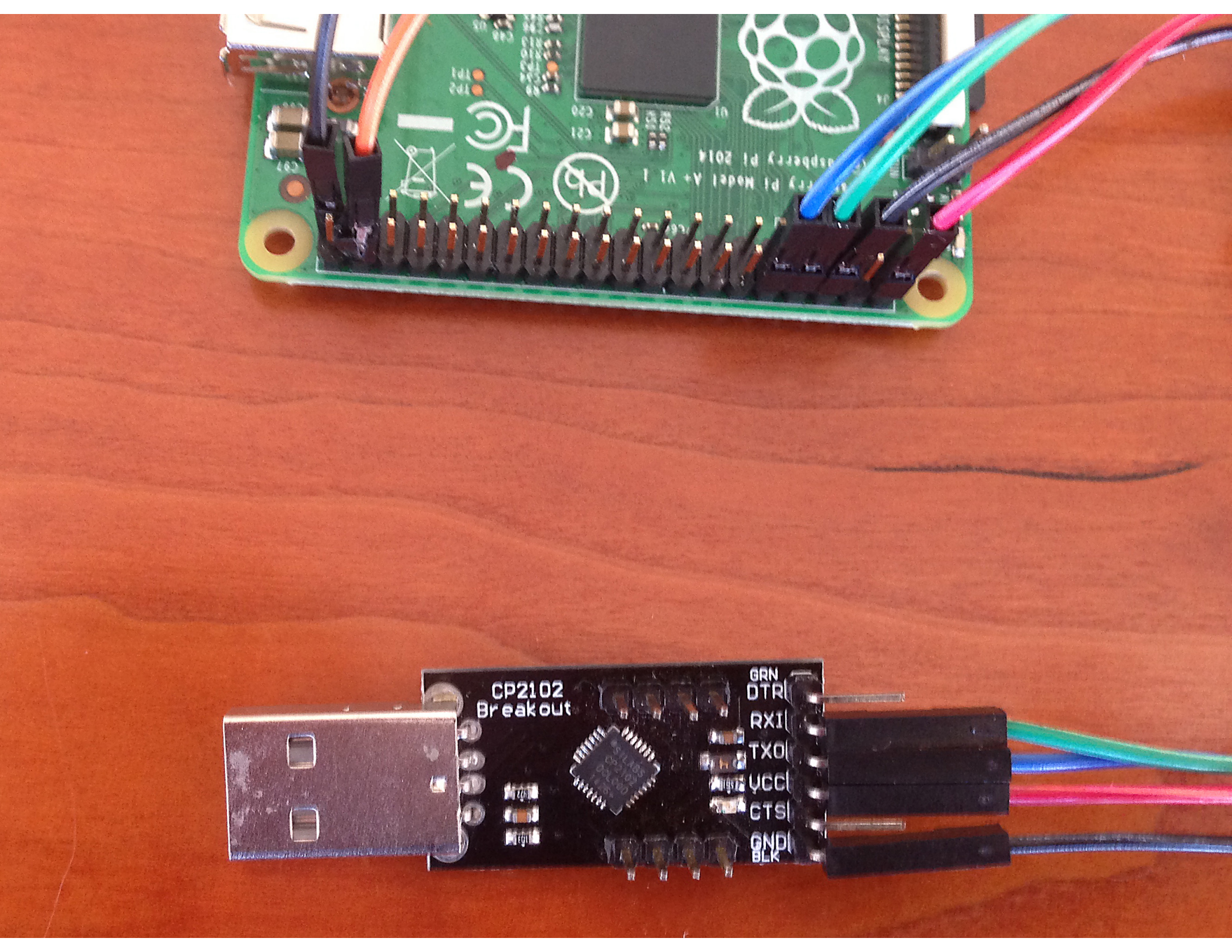
(1000000 usecs)/9600 ~ 104 usec/bit

https://learn.sparkfun.com/tutorials/serial-communication

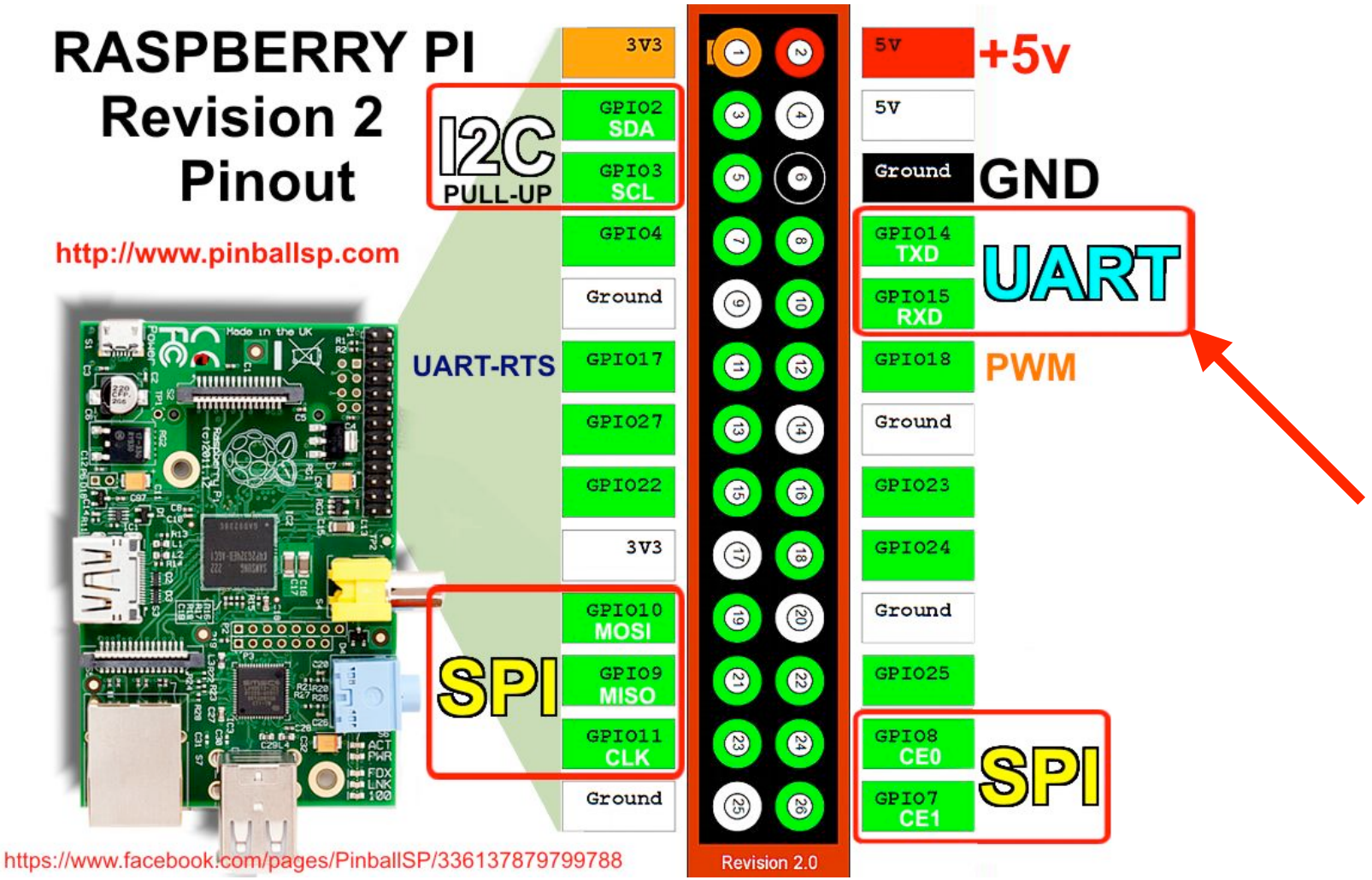
serial.c

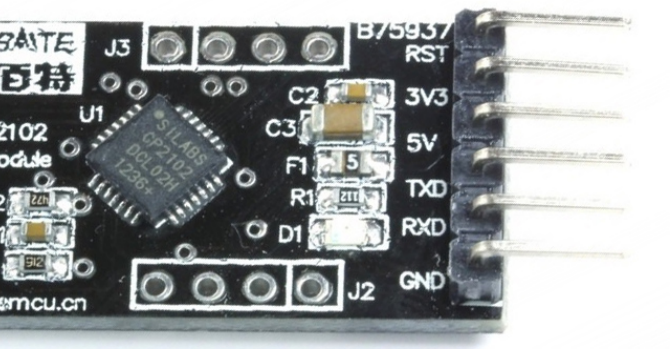

Saleae Logic 1.2.5 Beta – [Connected] – [100 MHz Digital, 0.1 s]
Options
Start
0 s : 10 ms
+7 ms
+8 ms
+9 ms
+1 ms
+2 ms
+3 ms
+4 ms
+5
h
e
l
l
o
COMMA
00 Channel 0
Async Serial - Serial
01 Channel 1
02 Channel 2
03 Channel 3
04 Channel 4
05 Channel 5
06 Channel 6
07 Channel 7
Capture
100 MHz, 10 M...
Annotations
Timing Marker Pair
| A1 - A2 | = ###
A1 @ ###
A2 @ ###
Analyzers
Async Serial
Decoded Protocols
Search Protocols
'199' (framing error)
G (framing error)
'167' (framing error)
\r
h
e
l
l

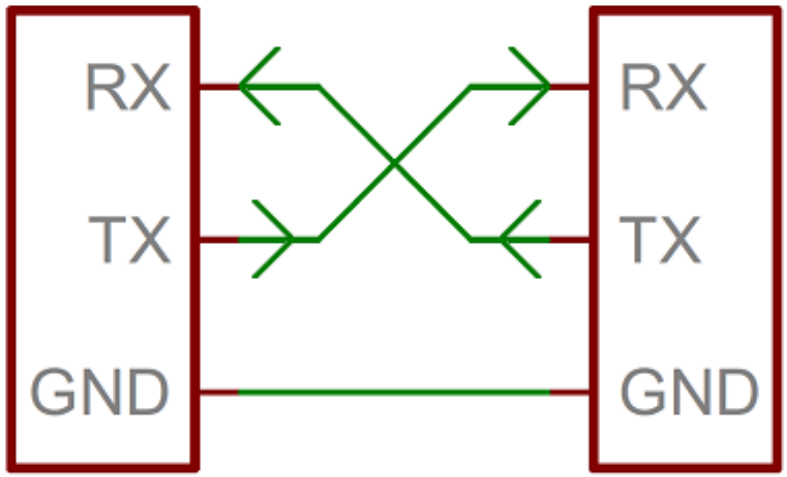
```
// hot wire TX

// device = tty (teletype)
// baud rate = 9600

% screen /dev/tty.SLAB_USBtoUART 9600

CTRL-A K - to exit
```

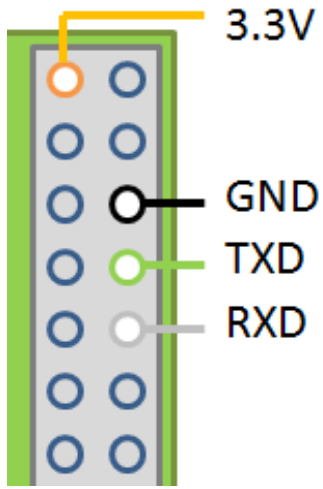

CP2102
Breakout
GRN
DTR
RXI
TXO
VCC
CTS
GND
BLK

GPIO Alternative Functions










```
% screen /dev/tty.SLAB_USBtoUART 115200
```

`uart.c`

Universal Asynchronous Receiver-Transmitter

GPIO ALT Function

BCM2835 has 54 general-purpose I/O pins. Every pin can be input, output, or one of 6 special functions (ALT0-ALT5), specific to each pin.

PIN	ALT0	ALT1	ALT2	ALT3	ALT4	ALT5
GPIO14	TXD0	SD6				TXD1
GPIO15	RXD0	SD7				RXD1

```
// BCM2835-ARM-Peripherals.pdf
// Sec 2: Mini-UART, SPI0, SPI1, pp 8-19
struct UART {
    unsigned data; // I/O Data
    unsigned ier;  // Interrupt enable
    unsigned iir;  // Interrupt identify/fifo
    unsigned lcr;  // line control register
    unsigned mcr;  // modem control register
    unsigned lsr;  // line status
    unsigned msr;  // modem status
    unsigned scratch;
    unsigned cntl; // control register
    unsigned stat; // status register
    unsigned baud; // baud rate register
} ;
```

echo.c

loop back test

Strings

String Functions

strcat(s1,s2)	Concatenate s2 to s1
strncat(s1,s2,n)	Concatenate at most n characters of s2 to s1
strcpy(s1,s2)	Copy s2 to s1; Note the direction of the copy!
strncpy(s1,s2,n)	Copy first n characters of s2 to s1
strlen(s)	Return length of string s, not counting '\0'
strcmp(s1,s2)	Compare s1 with s2; Return integer less than zero, equal to zero, or greater than zero
strncmp(s1,s2,n)	Compare only the first n characters of s1 and s2
strchr(s,c)	Return a pointer to first occurrence of character c in string s; return NULL if not found
strrchr(s,c)	Return a pointer to last occurrence of character c in string s; return NULL if not found
strstr(s1,s2)	Return a pointer to the first occurrence of string s1 in string s2; return NULL if not found
strstr(s1,s2)	Return a pointer to the first occurence of string s1 in string s2; return zero if not found

```
int strlen(const char *str)
{
  for (const char *s = str; *s; ++s)
      ;
  return (s - str);
}

// strlen("a")?
// strlen(NULL)?
// strlen('a')?
```

```
/* ANSI sez:
 *   The `strcpy' function copies the string pointed to by `s2' (including
 *   the terminating null character) into the array pointed to by `s1'.
 *   If copying takes place between objects that overlap, the behavior
 *   is undefined.
 *   The `strcpy' function returns the value of `s1'.  [4.11.2.3]
 */
char *
strcpy(char *s1, const char *s2)
{
    char *s = s1;
    while ((*s++ = *s2++) != 0)
        ;
    return s1;
}

// strcpy( NULL, "cs107e" )?
```

```
// Strings

char *s = “hello, world\n”;
char scopy[10];

strcpy(scopy, s); // Ok?
```

```
/* ANSI sez:
 *   The `strncpy' function copies not more than `n' characters (characters
 *   that follow a null character are not copied) from the array pointed to
 *   by `s2' to the array pointed to by `s1'.
 *   If the array pointed to by `s2' is a string that is shorter than `n'
 *   characters, null characters are appended to the copy in the array
 *   pointed to by `s1', until `n' characters in all have been written.
 */
char *
strncpy(char *s1, const char *s2, int n)
{
    char *s = s1;
    while (n > 0 && *s2 != '\0') {
       *s++ = *s2++;
       --n;
    }
    while (n > 0) {
       *s++ = '\0';
       --n;
    }
    return s1;
}
```

```
// Strings
char *s = “hello, world\n”;
char scopy[10];

strncpy(scopy, s, 10); // Ok?

strncpy(scopy, s, strlen(s)); // Ok?

strncpy(scopy, s, sizeof(scopy)); //Ok?
```

```
// Assignment 3

printf(const char *format, …);

printf(“%d, %d”, 1, 2);
printf(“%d, %d, %d”, 1, 2, 3);
printf(“%d, %d, %d”, 1, 2);

// Read about #include <stdarg.h>
// to use functions with
// variable numbers of arguments
```