The Serial Protocol
and
ASCII Character Codes

blink_s/blink.s

to

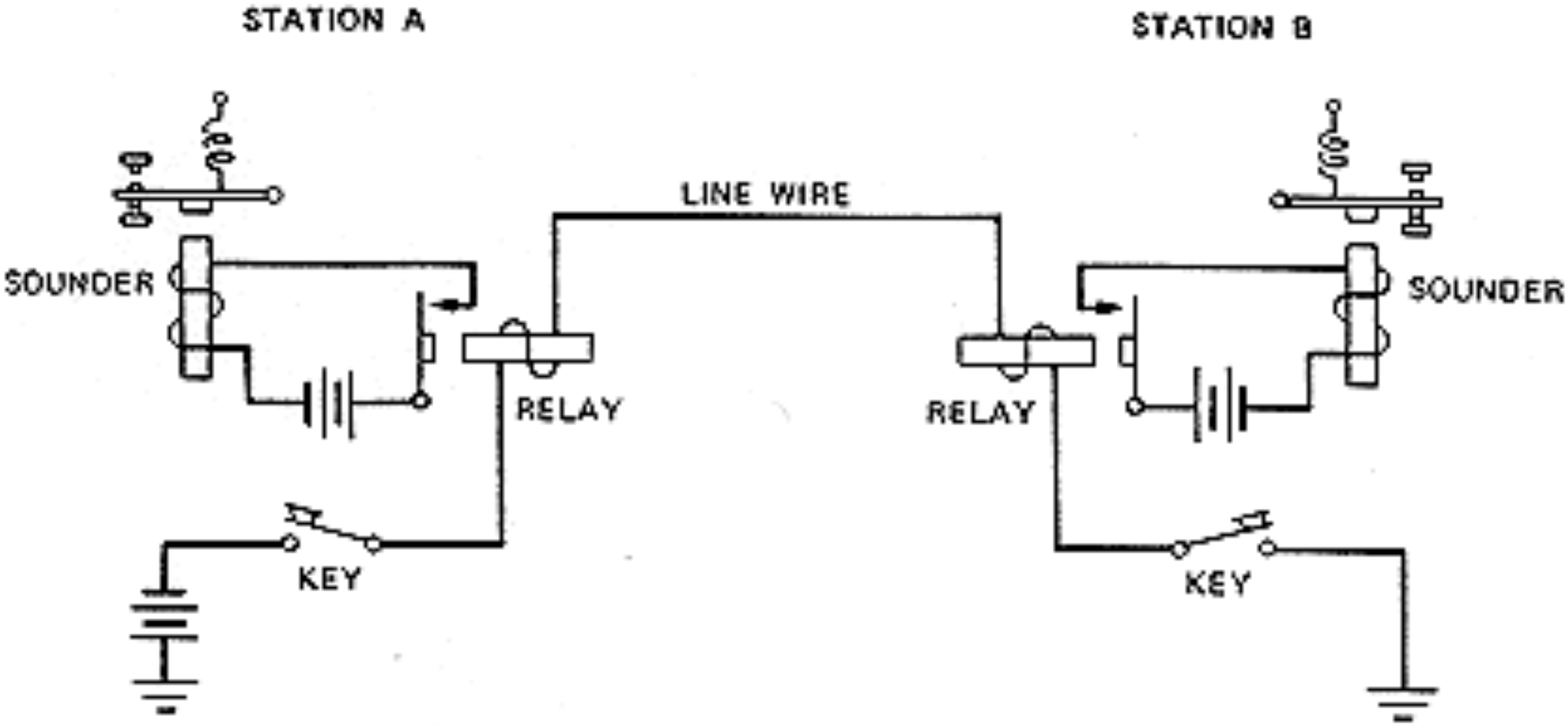
blink_c/blink.c

blink_c/blink.c

to

blink_gpio/blink.c

SIMPLEX TELEGRAPH

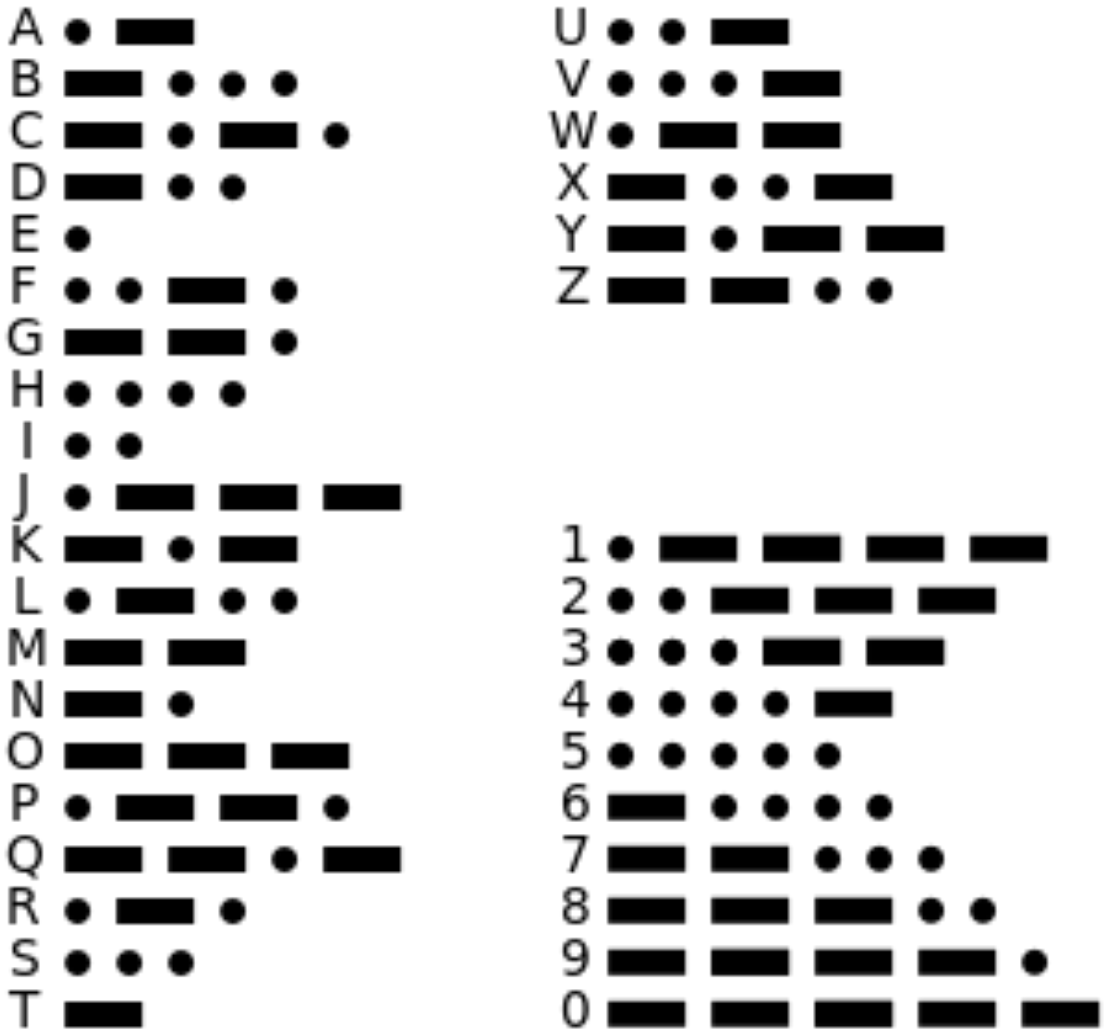


Elementary neutral telegraph circuit.

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.



https://en.wikipedia.org/wiki/Morse_code

blink_gpio/blink.c

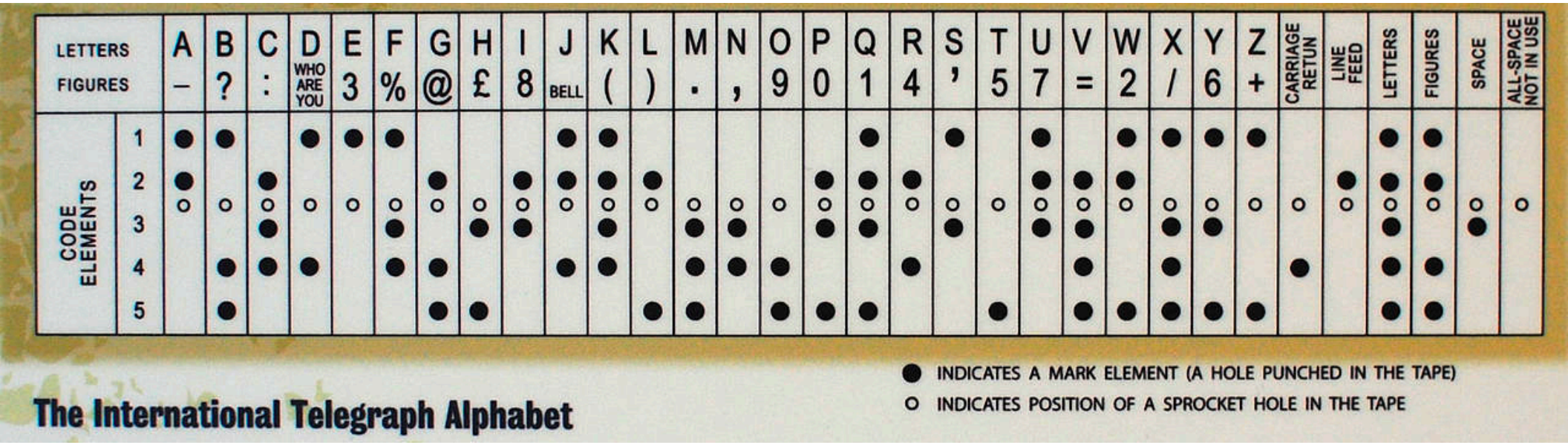
to

sos/sos.c

Teletype

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

5-bit Baudot Code (1870)



LETTERS / FIGURES		A –	B ?	C :	D WHO ARE YOU	E 3	F %	G @	H £	I 8	J BELL	K (	L)	M .	N ,	O 9	P 0	Q 1	R 4	S '	T 5	U 7	V =	W 2	X /	Y 6	Z +	CARRIAGE RETUN	LINE FEED	LETTERS	FIGURES	SPACE	ALL-SPACE NOT IN USE
CODE ELEMENTS	1	●	●		●	●	●				●	●						●		●		●		●	●	●	●			●	●		
	2	●	○	●	○	○	○	●	○	●	●	●	●	○	○	○	●	●	●	○	○	●	●	●	○	●	○	●	○	●	●	○	○
	3	○	○	●	○	○	●	○	●	●	○	●	○	●	●	○	●	●	○	●	○	●	●	○	●	●	○	○	○	●	●	●	○
	4		●	●	●		●	●			●	●		●	●	●	●	○					●	●	●	●		●		●	●		
	5		●					●	●				●	●		●	●				●		●	●	●	●				●	●		

● INDICATES A MARK ELEMENT (A HOLE PUNCHED IN THE TAPE)
○ INDICATES POSITION OF A SPROCKET HOLE IN THE TAPE

The International Telegraph Alphabet

Baud: Number of symbols per second

https://en.wikipedia.org/wiki/Baudot_code

```
% 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
```

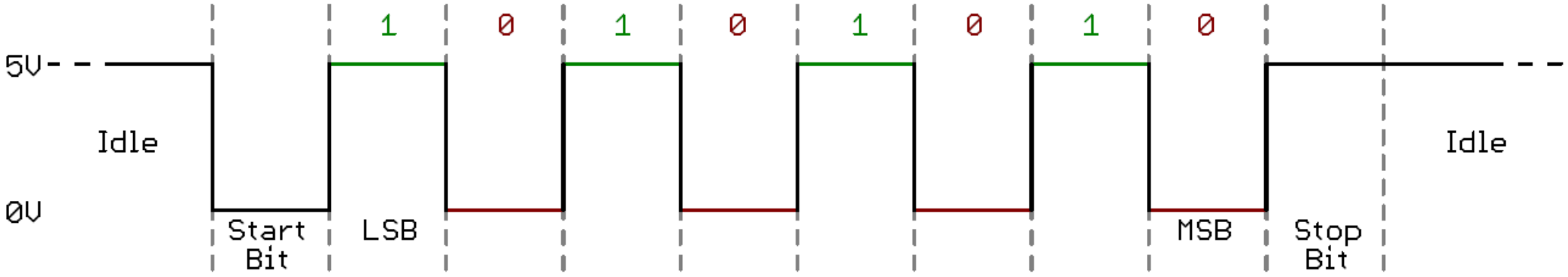
7-bit ASCII

"cs107e" =

\0
64
37
30
31
73
63

0x68 stands for 'h'

Asynchronous Serial Communication



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

9600 baud = 9600 bits/sec

(1000000 usecs)/9600 ~ 104 usec/bit

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

sos.c -> serial.c

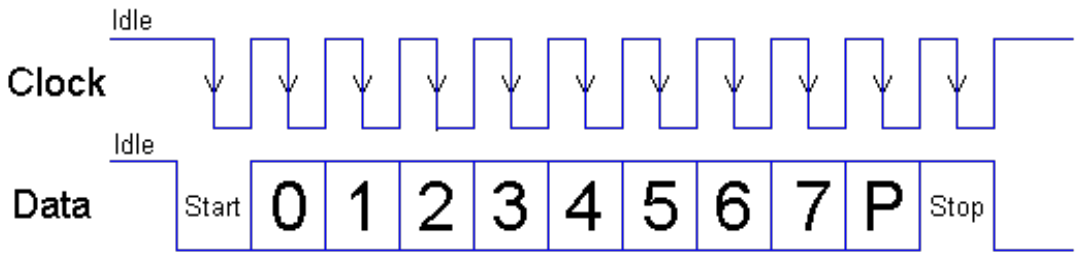
Logic Analyzer!

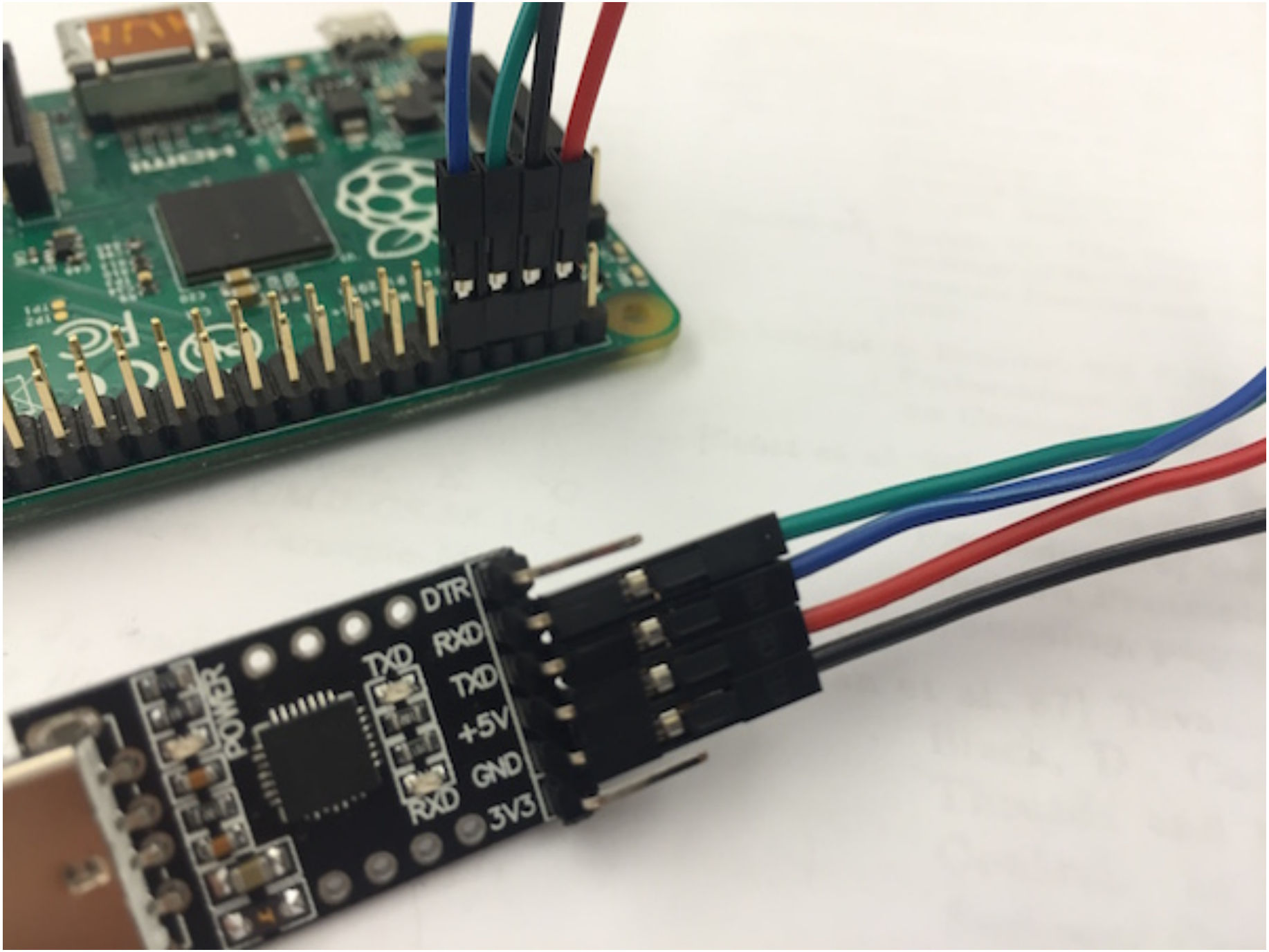
Synchronous Protocol: PS/2

Synchronous protocol: clock and data

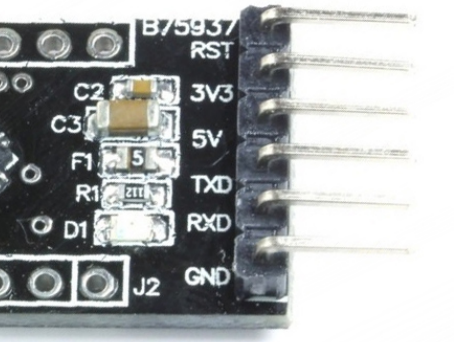
- Data changes when clock line is high
- Host reads data when clock is low

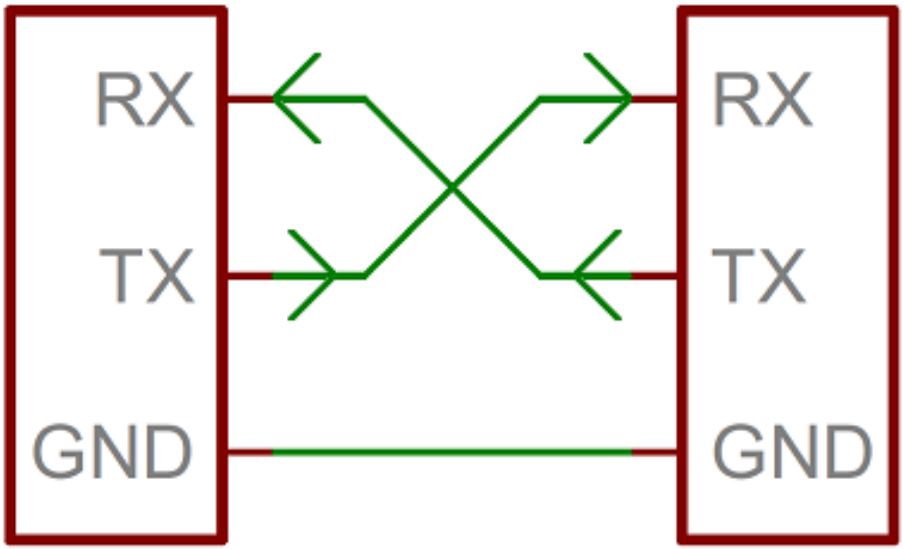
Payload: start bit, 8 data bits (lsb-first), *1 parity bit*, 1 stop bit (11 total)

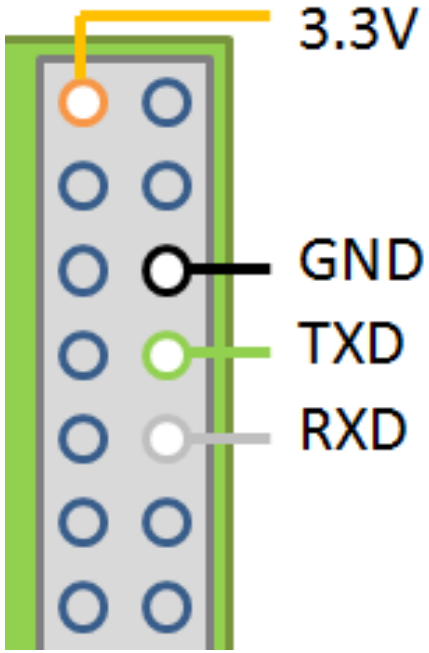



DTR
RXD
TXD
+5V
GND
3V3
TXD
RXD
POWER

```
// hot wire TX

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

% screen /dev/tty.usbserial-0001 9600

CTRL-A K - to exit
```







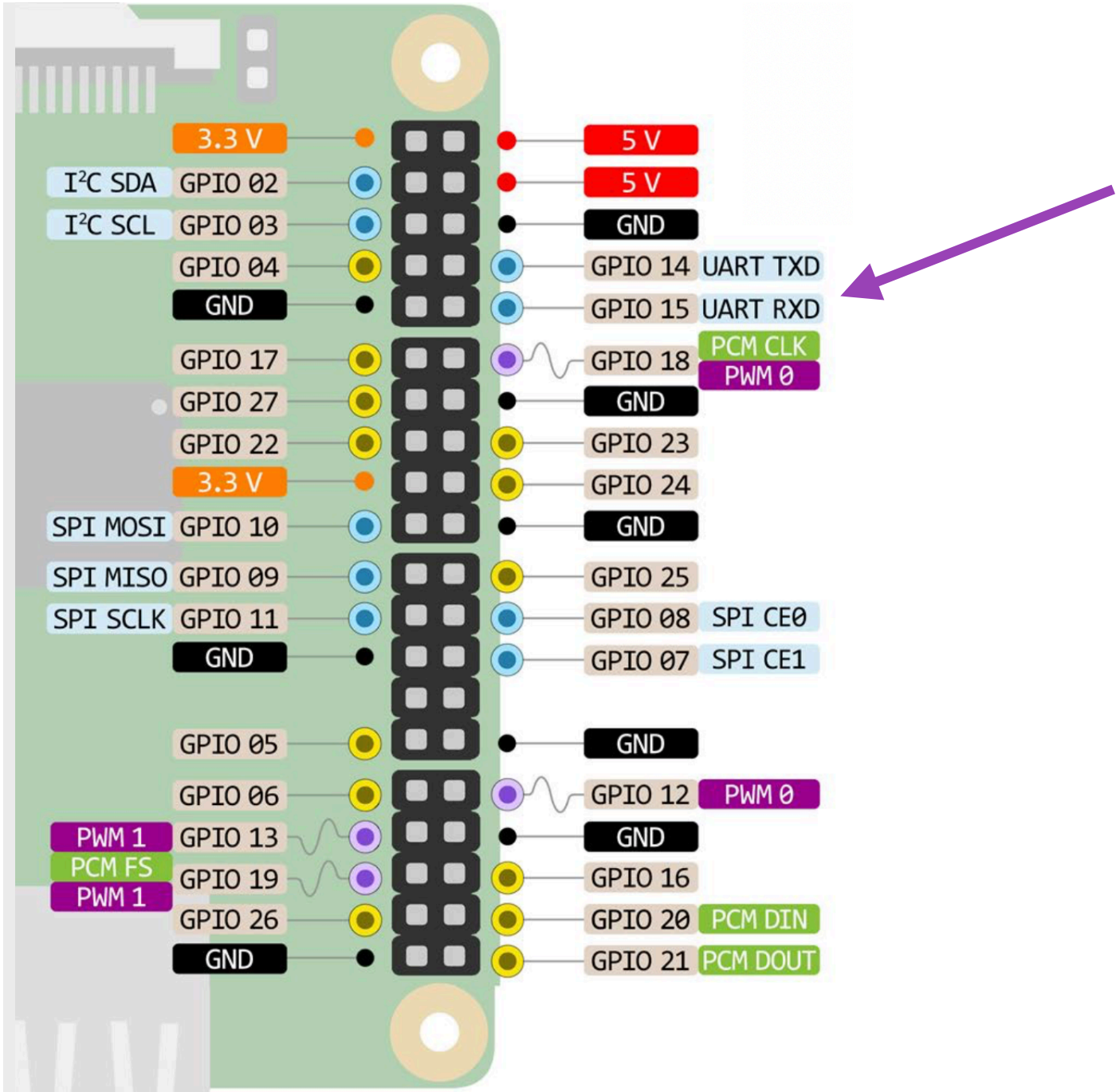

```
% screen /dev/tty.SLAB_USBtoUART 115200
```

`uart.h, uart.c`

Universal Asynchronous Receiver-Transmitter

```
// 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
} ;
```

GPIO Alternate Functions

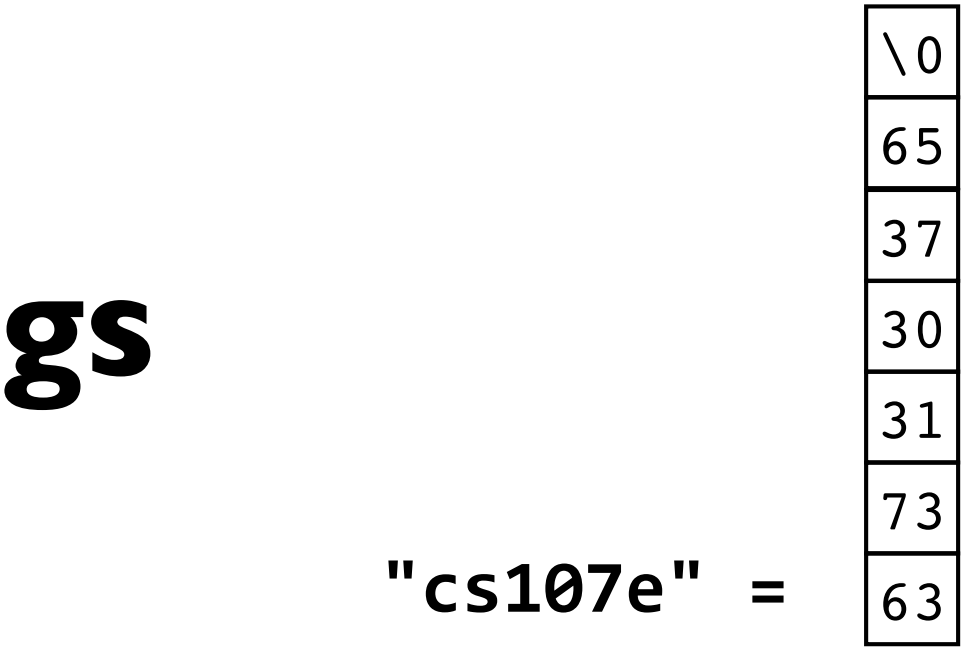


GPIO ALT Function

Every GPIO 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

C Strings



```
// Note '\0' at the end!
char arr[] =
    ['c','s','1','0','7','e','\0'];
// short cut
char arr[] = "cs107e";

char ch = arr[1]; // ok? ch?

char *ptr = "cs107e";
ch = ptr[1];

arr = ptr; // ok?
ptr = arr; // ok?
```

String Functions in string.h

```
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 occurrence of string s1  in
                    string s2; return zero if not found
```

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

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

```
// Assignment 3

/*
** printf(const char *format, …);
*/

printf("%d, %d\n", 1, 2);
printf(“%x\n", 0x20200008);
printf("%c\n", 'a');
printf("%s\n", "hello");

// Lots of practice with pointers!
```