HED®

Hydro Electronic Devices, Inc.

Intelligent Electronic Controls for Mobile Equipment

Hydro Electronic Devices, Inc.

Basic Electronics

Training Objectives

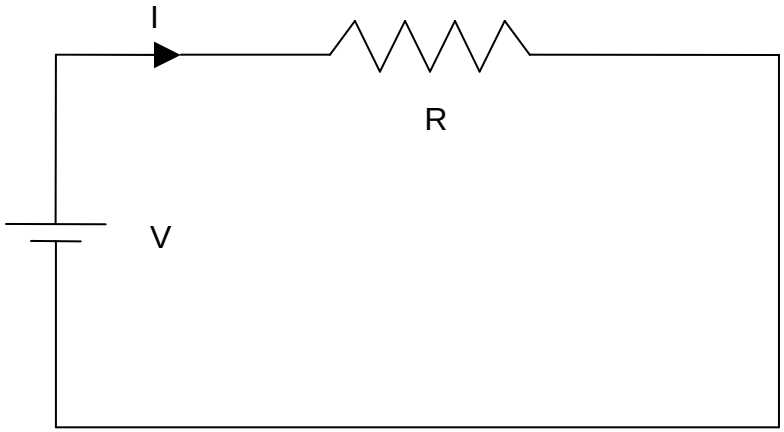
- **Provide knowledge / basic understanding of electronics concepts**

- **Familiarize / provide definitions of key terminology**

Ohm's Law

Voltage (V) = Resistance (Ohms) X Current (Amps)

V = R X I

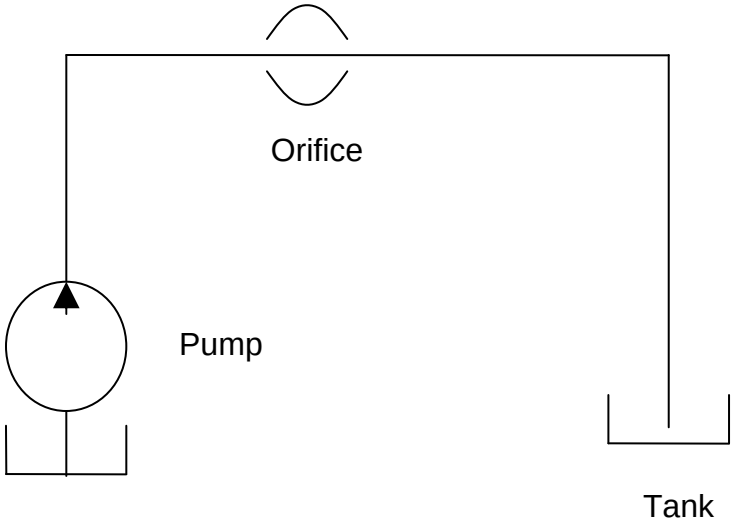


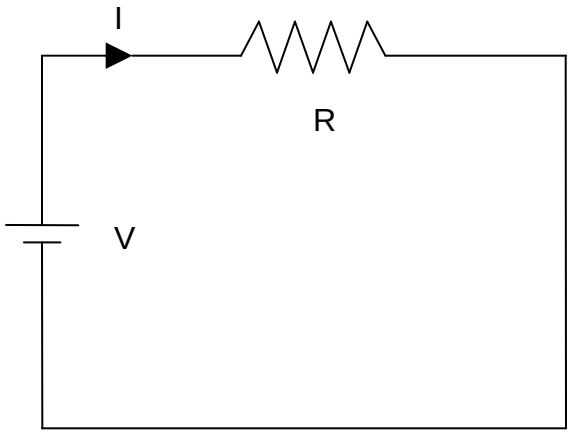
Hydraulics vs. Electronics

Hydraulic System	Electrical System
Hose & Tubing	**Board traces & wires**
Flow	**Current**
Pressure	**Voltages**
Check valves	**Diodes**
Orifices	**Resistors**
Accumulators	**Capacitors**
Surges	**Spikes**

Note: Reference pages 5-6 in “Your Guide to the Electronic Control of Fluid Power”

Equivalent Hydraulic circuit





Hydraulic

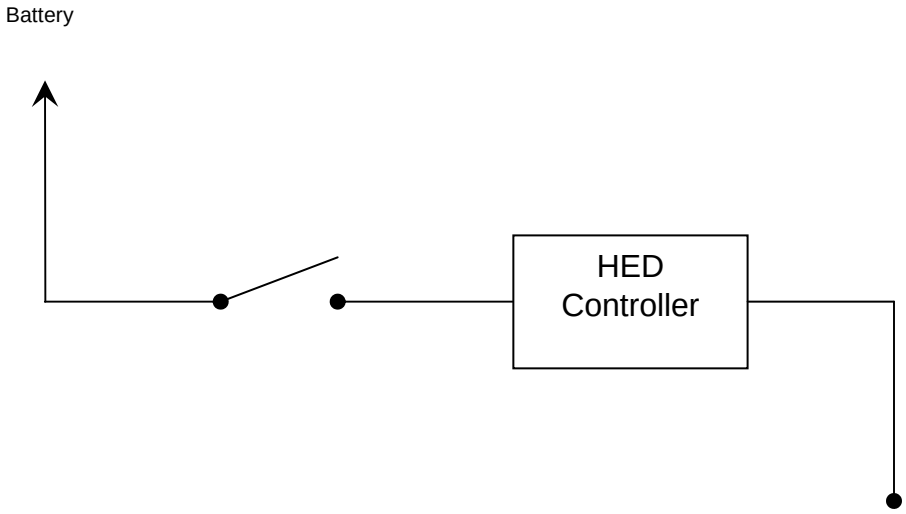
Electronic

Types of Inputs

- **Inputs**
  - **Switch-to-Battery**
  - **Switch-to-Ground**
  - **Analog**
  - **Frequency**
  - **RTD**

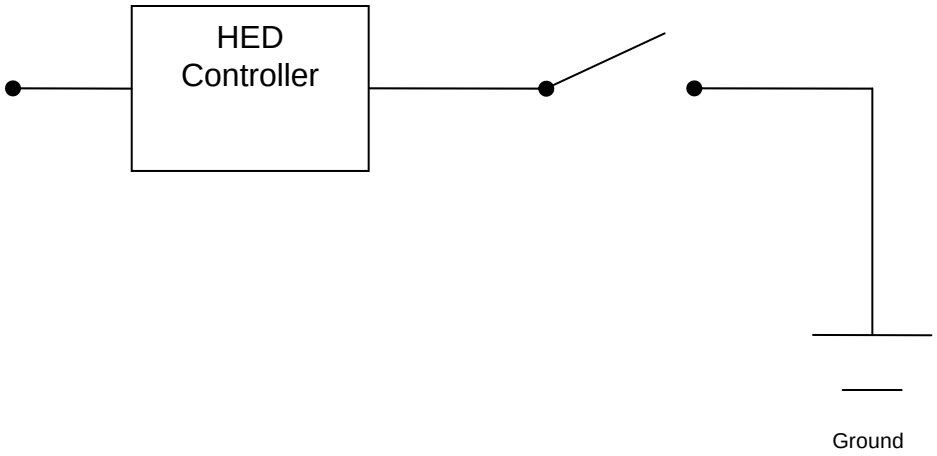
Switch to Battery (STB)

- **Switch on battery side of load**



Switch to Ground (STG)

- **Switch on Ground side of load**



Analog

- **Also known as a/d, analog to digital, voltage to digital**
- **Provides controller with a voltage**
  - **Voltage is between 0 to the defined upper voltage range (example 0 – 5 VDC)**
  - **Steps are based on resolution**
- **Resolutions**
  - **8 bit, range is from 0 – 255**
  - **10 bit, range is from 0 – 1023**
  - **12 bit, range is from 0 – 4095**
- **Common use: joysticks, foot pedals, adjustment pots**

Joysticks

- **Common analog input**
- **Output ranges can vary**
- **Example: 10% joystick (supplied with 5VDC)**
  - **Center is 2.5VDC**
  - **Maximum output is 3VDC**
  - **Minimum output is 2VDC**

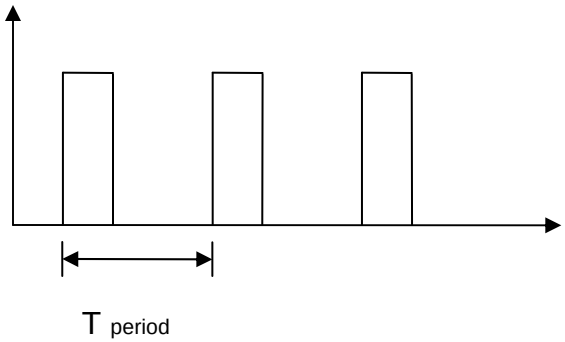
Frequency

- The number pulses per second
- Frequency = 1/period
- Example:

  If t_{period} = 0.001 sec

  Frequency = 1/0.001

  = 1000 Hz



- Units is in Hz (cycles per second)
- Examples
  - Engine speeds
  - Drum count
  - Water flow

RTD

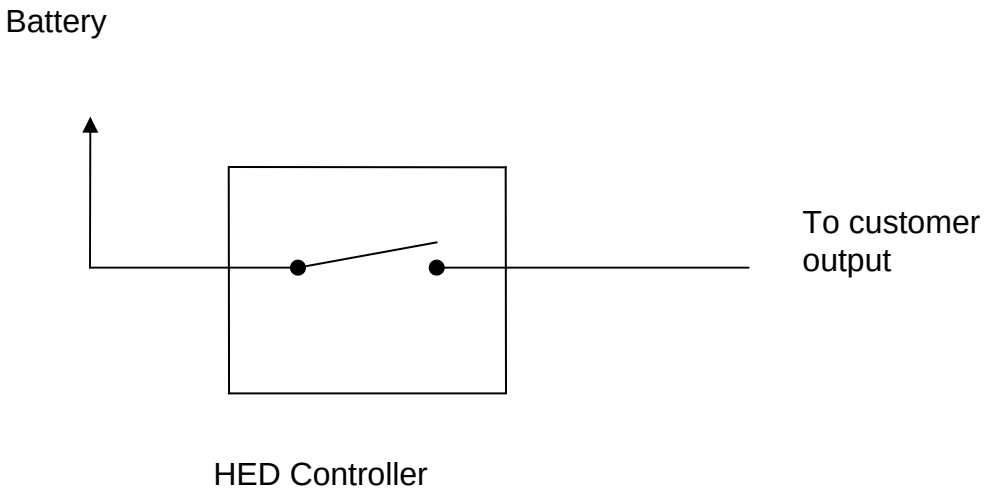
- **Resistive to Digital**
- **Resistance Temperature Detector**
- **Controller measure change in resistance of sensor**
- **Example ranges 0-250 Ohms or 0-4,000 Ohms**
- **Used:**
  - **Engine temperature sensors**
  - **Fuel gauges**

Types of Outputs

- **Outputs**
  - **Sinking**
  - **Sourcing**
  - **Analog**
  - **PWM**
  - **Digital**
  - **Servo**

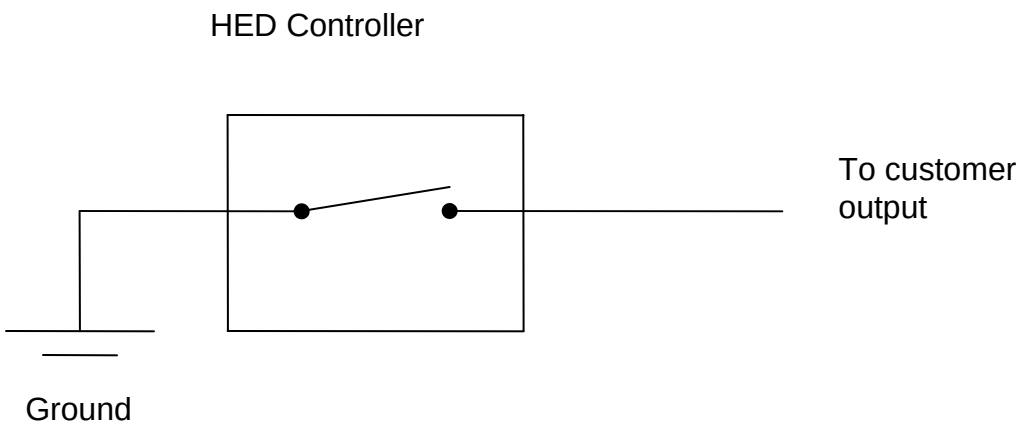
Sourcing Output

- **Controller connects the customer output device to battery**



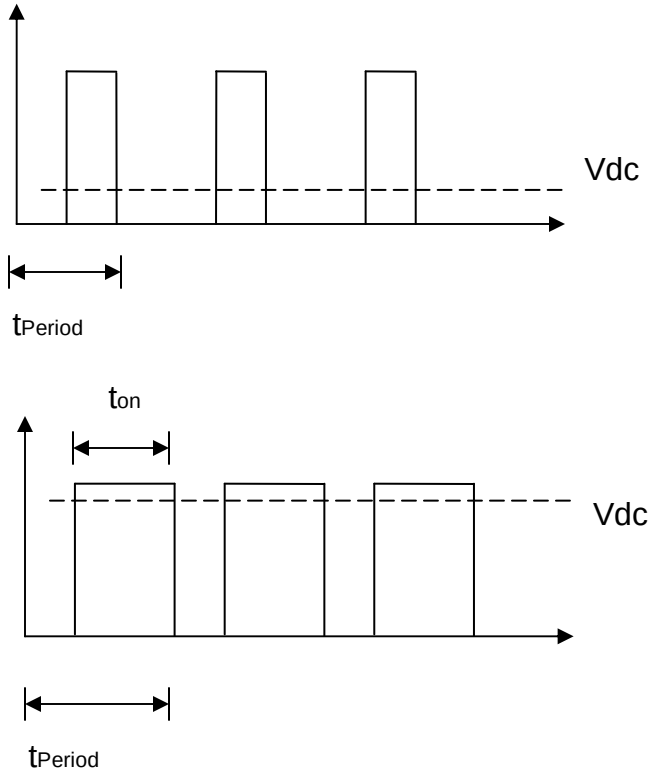
Sinking Output

- **Controller connects the customer output device to ground**



PWM Output

- **Varying the “ON” time will result in a higher Vdc**
- **Duty cycle is the percentage on over the full period**
- **Duty cycle = $(t_{on})/(t_{period})x100$**
- **Sinking or Sourcing**

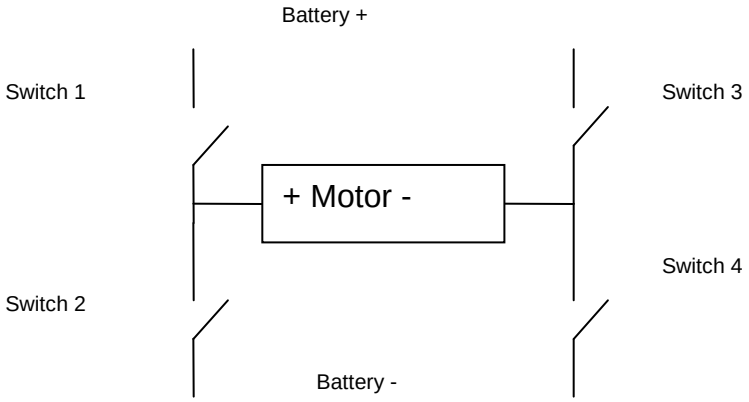


Digital

- **Is a simple on or off output.**
- **Can be sourcing or sinking**
- **If On and sourcing, supplying battery from the controller**

Servo

- **Allows for controlling a motor/valve in two direction (bi-direction)**
- **Eg: H-bridge**



Other terms

- **Debounce time**
- **Frequency gauges**
- **Resistance gauges**
- **Numbering Systems**
- **Truth tables**
- **Microcontroller**

Debounce Time

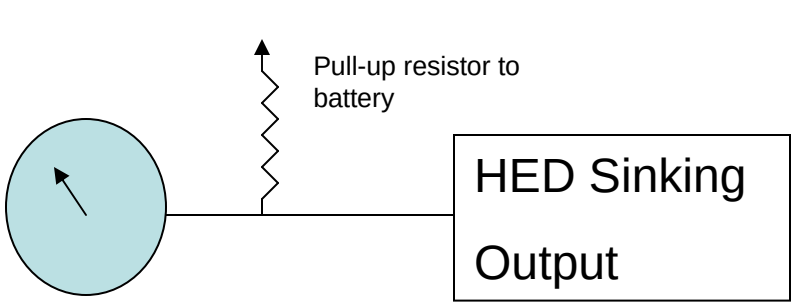
- **The amount of time required for a mechanical switch to settle in the on/off state**

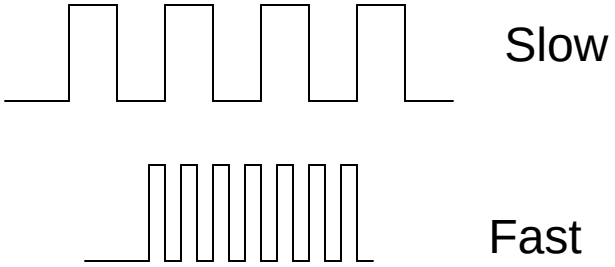
- **Debounce ON**

- **Debounce OFF**

Frequency gauges

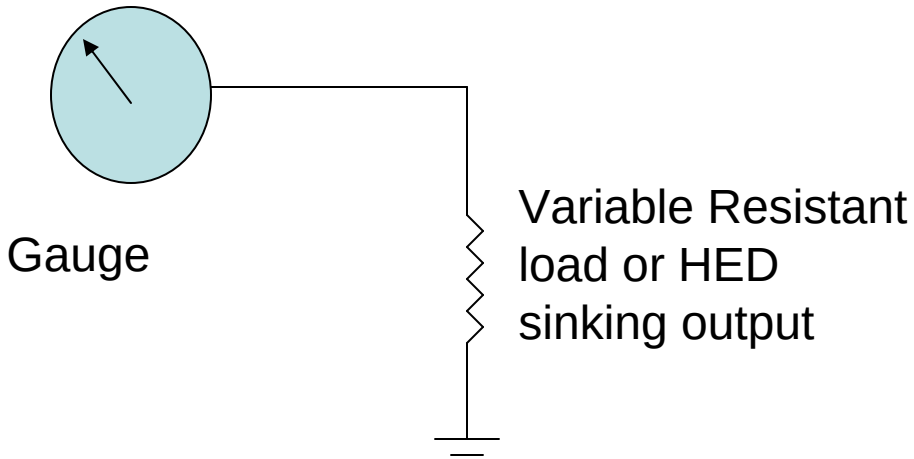
- **Driven by Sinking or Sourcing**
- **Sinking need to add a pull-up resistor between the gauge and output. Sourcing built in resister in gauge.**
- **Higher the frequency of the output, the higher the needle will rise**





Resistance gauges

- **Typically driven by supplying a current across a varying resistor sensor (eg: RTD sensor)**
- **HED drives it by varying the duty cycle, which in returns looks like the resistance is varying.**
- **Can only be driven by sinking outputs**



Numbering Systems

- **Decimal = base 10**
- **Binary = base 2**
- **Hex = base 16**

Binary

- **What is sent down the CAN bus**
- **Example: $1001_2 = 9_{10}$**
- **Single digit is called a bit**
- **4 bits equal a nibble**
  - **Nibble → 1111_2**

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HEX

- **Base is 16**
- **Example: $7F2_{16} = 2034_{10}$**
- **4 bits is a hex digit**
  - **eg: $1111_2 = F_{16}$**
- **2 hex digits are a byte (or 8 bits binary)**
  - **$1111\ 1111_2 = FF_{16}$ = byte**
- **4 hex digits or 2 bytes is a word**
  - **$FF\ FF_{16}$ = word**

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Number Chart

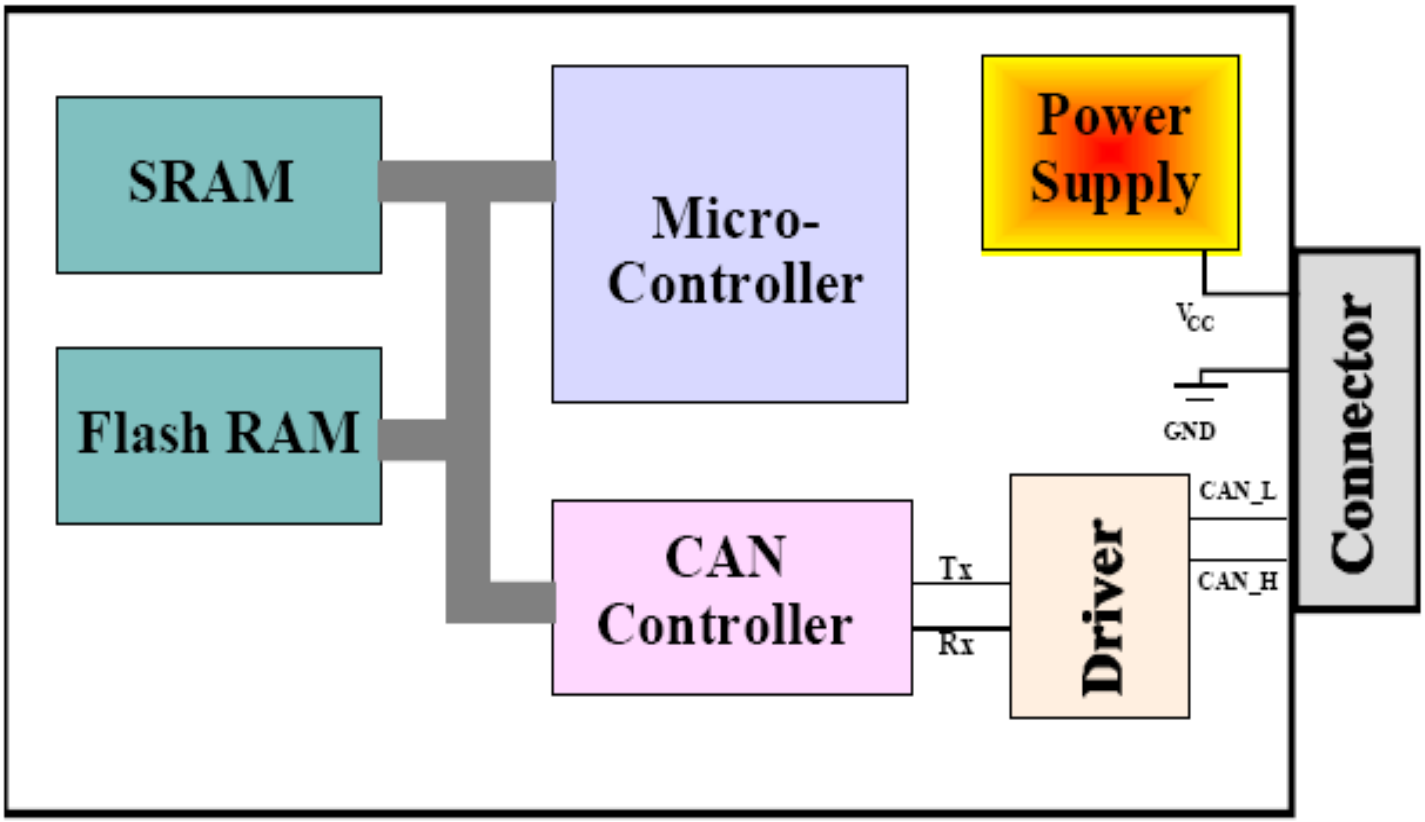
Binary	Hex	Decimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	A	10
1011	B	11
1100	C	12
1101	D	13
1110	E	14
1111	F	15

Truth tables

- **A truth table tells the output response based on the table's inputs.**
- **Example:**

	J1939 Msg from Engine stopped	Beacon light switch	Left turn signal	Right turn signal	Hazard lights
Warning indicator lamp	1				
Engine indicator lamp	1				
Beacon light output		1			
Left indicator lamp			1		1
Right indicator lamp				1	1

Microcontroller



CAN Controller

- **Newer processors have them built in**
  - **Up to five controllers = 5 CAN port**
- **If not built in**
  - **Dependant on the real estate room on the board**
  - **And memory need to store the CAN messages**

Memory

- **Flash**
  - **Application code is stored**
  - **Saves the information even if powered off**
- **RAM (read access memory)**
  - **Stores data during process (counters, timers, variables)**
  - **Lose when powered off**
- **EEPROM**
  - **Stores data usually changed during set-up**
  - **Has limit the number of times it can be written to**

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