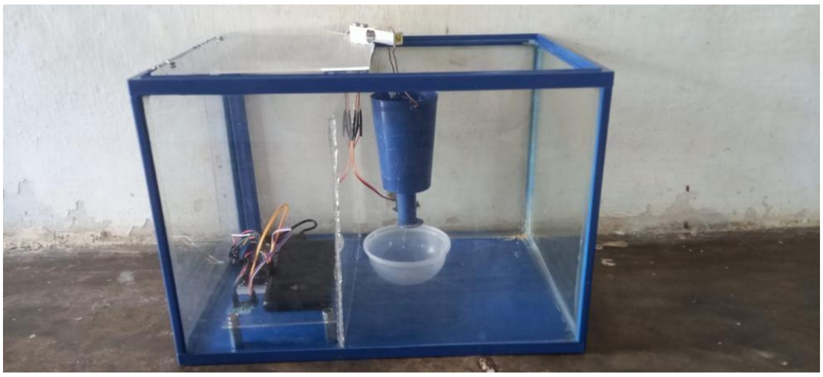
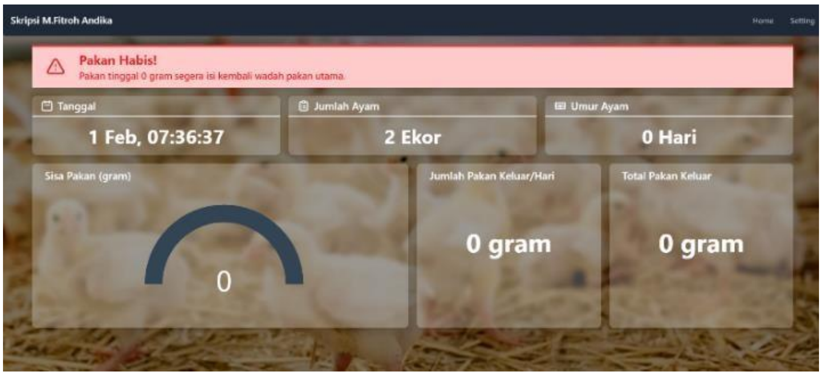
LAMPIRAN

1. Bentuk alat dan Tampilan Website





2. Kode Program Arduino

```
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>
#include <ezTime.h>
#include <Servo.h>
#include <HX711.h>

// Inisialisasi Variable Hari, Bulan, dan Zona Waktu
Timezone tz;
String bulan[] = {"Jan", "Feb", "Maret", "April", "Mei", "Juni", "Juli", "Agust", "Sept",
"Okt", "Nov", "Des"};
String hari[] = {"Minggu", "Senin", "Selasa", "Rabu", "Kamis", "Jumat", "Sabtu"};

// Inisialisasi SSID, Password, dan Server
const char *ssid = "Kontrakan_plus";
const char *pass = "HURUFKECIL321";
const char* server = "http://fitroh.my.id/kirimdata.php";


// Config Load Cell
```

```
#define DOUT  D7
#define CLK   D6
HX711 scale;
float calibration_factor = 912; //Hasil Kalibrasi
float units;

// Inisialisasi Servo
Servo myservo;

void setup() {
  WiFi.begin(ssid, pass);
  Serial.begin(115200);
  Serial.print("Connecting to ");
  Serial.print(ssid);
  while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.print(".");
  }
  Serial.println();

  // Set Config Load Cell
  scale.begin(DOUT, CLK);
  scale.set_scale();
  scale.tare();
  long zero_factor = scale.read_average(); //Get a baseline reading
  Serial.print("Zero factor: "); //This can be used to remove the need to tare the scale.
Useful in permanent scale projects.
  Serial.println(zero_factor);

  myservo.attach(D3);

  waitForSync();
  tz.setLocation("Asia/Jakarta");
  delay(5000);
}

void loop() {
  String currentDate = hari[tz.dateTime("w").toInt()] + ", " + tz.dateTime("d") + " " +
bulan[tz.dateTime("n").toInt() - 1];
  String currentTime = tz.dateTime("H:i:s");
  Serial.println(currentDate + " - " + currentTime);
```

```
// Load Cell Sensor
scale.set_scale(calibration_factor); //Adjust to this calibration factor
Serial.print("Reading: ");
units = scale.get_units(), 1;
if (units < 0) {
  units = 0.00;
}
Serial.print("Berat: ");
Serial.print(units);
Serial.println(" Gram");
int sensor = units;
Serial.println(sensor);

int siklus;
if (WiFi.status() == WL_CONNECTED) {
  WiFiClient client;
  HTTPClient http;
  Serial.print("Sending Data");
  http.begin(client, server);
  http.addHeader("Content-Type", "application/x-www-form-urlencoded");
  String dataSensor = "sensor=" + (String)sensor;
  int httpCode = http.POST(dataSensor);
  siklus = http.getString().toInt();
  Serial.print(" => Response : ");
  Serial.println(httpCode);
  http.end();
} else {
  Serial.println("WiFi Disconnected");
}

siklus = 2;
currentTime = tz.dateTime("H:i"); // Jam Internet
//currentTime = "12:00";
String minggu1[] = {"06:00", "08:00", "10:00", "12:00", "14:00", "12:20", ""};
String minggu2[] = {"06:00", "08:00", "10:00", "12:00", "14:00", "16:00", "19:42",
""};
String minggu3[] = {"06:00", "08:00", "10:00", "12:00", "14:00", "16:00", ""};
String minggu4[] = {"06:00", "08:00", "10:00", "12:00", "14:00", "16:00", ""};
String minggu5[] = {"06:00", "08:00", "10:00", "12:00", "14:00", "16:00", ""};
String minggu6[] = {"06:00", "08:00", "10:00", "12:00", "14:00", "16:00", ""};
switch (siklus) {
```

```
    case 1:
      Serial.println("Minggu Ke-1");
      bukaServo(currentTime, minggu1, 2000);
      break;
    case 2:
      Serial.println("Minggu Ke-2");
      bukaServo(currentTime, minggu2, 2000);
      break;
    case 3:
      Serial.println("Minggu Ke-3");
      bukaServo(currentTime, minggu3, 3000);
      break;
    case 4:
      Serial.println("Minggu Ke-4");
      bukaServo(currentTime, minggu4, 1000);
      break;
    case 5:
      Serial.println("Minggu Ke-5");
      bukaServo(currentTime, minggu5, 2000);
      break;
    case 6:
      Serial.println("Minggu Ke-6");
      bukaServo(currentTime, minggu6, 4000);
      break;
  }
  Serial.println();
  delay(5000);
}
void bukaServo(String currentTime, String waktuMakan[], int lamaDelay) {
  int index = 0;
  while (waktuMakan[index] != "") {
    if (currentTime == waktuMakan[index]) {
      Serial.println("Sekarang Waktu Makan => " + waktuMakan[index]);
      myservo.write(180);
      delay(2000);
      myservo.write(0);
      delay(lamaDelay);
      break;
    }
    index += 1;
  }
}
```

3. Kode Program Website

```
<?php
  header("Content-Type: application/json; charset=UTF-8");
  date_default_timezone_set('Asia/Jakarta');
  require('connection.php');

  function currentDate() {
    return '16 Feb, 08:00:54';
    //return date('d M, H:i:s');
  }

  function umurAyam() {
    $now = date("Y-m-d");
    $sql = mysqli_query(connecting(), "SELECT DATEDIFF('$now', tanggal) AS hari
FROM siklus");
    $data = mysqli_fetch_array($sql);
    //return $data['hari'];
    return '1';
  }

  function pakanKeluar() {
    $sql = mysqli_query(connecting(), "SELECT pakan_keluar FROM sensor");
    $result = mysqli_fetch_array($sql);
    //return $result['pakan_keluar'];
    return '20';
  }

  function sensor() {
    $sql = mysqli_query(connecting(), "SELECT * FROM sensor");
    $data = mysqli_fetch_array($sql);
    return $data["nilai_sensor"];
  }

  function totalKeluar() {
    $sql = mysqli_query(connecting(), "SELECT total_pakan_keluar FROM sensor");
    $result = mysqli_fetch_array($sql);
    return $result['total_pakan_keluar'];
  }

  $data = [
    'waktu' => currentDate(),
    'umur_ayam' => umurAyam(),
    'pakan_keluar' => pakanKeluar(),
```

```
    'total_keluar' => totalKeluar(),
    'sensor' => sensor()
  ];
  echo json_encode($data);
?>

<?php
    require('connection.php');
    $konek = connecting();

    $nilai = $_POST["sensor"];

    $sql = mysqli_query($konek, "SELECT nilai_sensor FROM sensor");
    $result = mysqli_fetch_array($sql);
    $berat = $result['nilai_sensor'];
    if($nilai < $berat){
        $total = $berat - $nilai;
        $sql = mysqli_query($konek, "SELECT total_pakan_keluar FROM sensor");
        $result = mysqli_fetch_array($sql);
        $totalKeluar = $result['total_pakan_keluar'];
        $totalKeluar += $total;
        mysqli_query($konek,"update sensor set pakan_keluar='$total',
total_pakan_keluar='$totalKeluar'");
    }
    mysqli_query($konek,"update sensor set nilai_sensor='$nilai'");
    date_default_timezone_set('Asia/Jakarta');
    $now = date("Y-m-d");
    $sql = mysqli_query(connecting(), "SELECT DATEDIFF('$now', tanggal) AS hari
FROM siklus");
    $data = mysqli_fetch_array($sql);
    if (in_array($data['hari'], range(0, 7))) {
        echo 1;
    } elseif (in_array($data['hari'], range(8, 14))) {
        echo 2;
    } elseif (in_array($data['hari'], range(15, 21))) {
        echo 3;
    } elseif (in_array($data['hari'], range(22, 28))) {
        echo 4;
    } elseif (in_array($data['hari'], range(29, 35))) {
        echo 5;
    } elseif (in_array($data['hari'], range(36, 42))) {
        echo 6;
    }
?>
```

1 Introduction

Espressif Systems' Smart Connectivity Platform (ESCP) of high performance wireless SOCs, for mobile platform designers, provides unsurpassed ability to embed Wi-Fi capabilities within other systems, at the lowest cost with the greatest functionality.

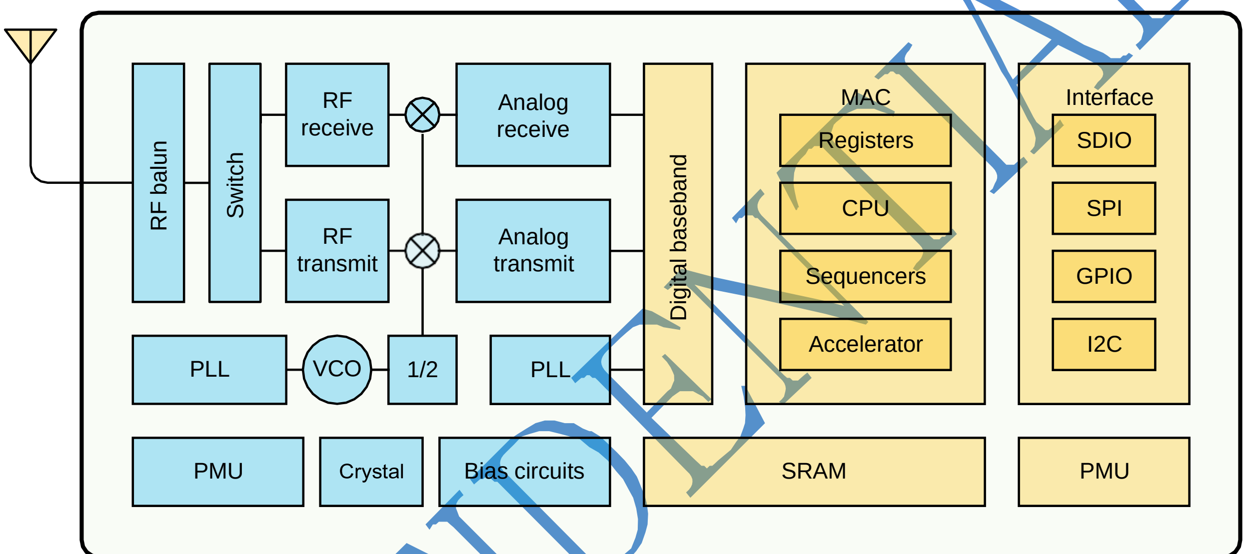


Figure 1: ESP8266 Block Diagram

2 Technology Overview

ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements.

Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any microcontroller-based design with simple connectivity through UART interface or the CPU AHB bridge interface.

ESP8266 on-board processing and storage capabilities allow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. With its high degree of on-chip integration, which includes the antenna switch balun, power management converters, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

Sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing for low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigatio

3 Features

- 802.11 b/g/n protocol
- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and power management units
- +19.5dBm output power in 802.11b mode
- Integrated temperature sensor
- Supports antenna diversity
- Power down leakage current of < 10uA
- Integrated low power 32-bit CPU could be used as application processor
- SDIO 2.0, SPI, UART
- STBC, 1×1 MIMO, 2×1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4µs guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)

3 Ultra Low Power Technology

ESP8266 has been designed for mobile, wearable electronics and Internet of Things applications with the aim of achieving the lowest power consumption with a combination of several proprietary techniques. The power saving architecture operates in 3 modes: active mode, sleep mode and deep sleep mode.

By using advance power management techniques and logic to power-down functions not required and to control switching between sleep and active modes, ESP8266 consumes less than 12uA in sleep mode and less than 1.0mW (DTIM=3) or less than 0.5mW (DTIM=10) to stay connected to the access point.

When in sleep mode, only the calibrated real-time clock and watchdog remains active. The real-time clock can be programmed to wake up the ESP8266 at any required interval.

The ESP8266 can be programmed to wake up when a specified condition is detected. This minimal wake-up time feature of the ESP8266 can be utilized by mobile device SOCs, allowing them to remain in the low-power standby mode until Wi-Fi is needed.

In order to satisfy the power demand of mobile and wearable electronics, ESP8266 can be programmed to reduce the output power of the PA to fit various application profiles, by trading off range for power consumption.

5.1 Highest Level of Integration

By integrating the costliest components such as power management unit, TR switch, RF balun, high power PA capable of delivering +25dBm (peak), ESP8266 ensures that the BOM cost is the lowest possible, and ease of integration into any system.

With ESP8266, the only external BOM are resistors, capacitors, and crystal.

4 ESP8266 Applications

4.1 Smart power plugs

- Home automation
- Mesh network
- Industrial wireless control
- Baby monitors
- IP Cameras
- Sensor networks
- Wearable electronics
- Wi-Fi location-aware devices
- Security ID tags
- Wi-Fi position system beacons

5 Specifications

7.1 Current Consumption

The following current consumption is based on 3.3V supply, and 25°C ambient, using internal regulators. Measurements are done at antenna port without SAW filter. All the transmitter's measurements are based on 90% duty cycle, continuous transmit mode.

Mode	Min	Typ	Max	Unit
Transmit 802.11b, CCK 1Mbps, P_{OUT}=+19.5dBm		215		mA
Transmit 802.11b, CCK 11Mbps, P_{OUT}=+18.5dBm		197		mA
Transmit 802.11g, OFDM 54Mbps, P_{OUT} =+16dBm		145		mA
Transmit 802.11n, MCS7, P_{OUT}=+14dBm		135		mA
Receive 802.11b, packet length=1024 byte, -80dBm		60		mA
Receive 802.11g, packet length=1024 byte, -70dBm		60		mA
Receive 802.11n, packet length=1024 byte, -65dBm		62		mA
Standby		0.9		mA
Deep sleep		10		uA
Power save mode DTIM 1		1.2		mA
Power save mode DTIM 3		0.86		mA
Total shutdown		0.5		uA

7.2 RF Performance

The following are measured under room temperature conditions with 3.3V and 1.1V power supplies.

Description	Min	Typical	Max	Unit
Input frequency	2412		2484	MHz
Input impedance		50		Ω
Input reflection			-10	dB
Output power of PA for 72.2Mbps	14	15	16	dBm
Output power of PA for 11b mode	17.5	18.5	19.5	dBm
Sensitivity				
CCK, 1Mbps		-98		dBm
CCK, 11Mbps		-91		dBm
6Mbps (1/2 BPSK)		-93		dBm
54Mbps (3/4 64-QAM)		-75		dBm
HT20, MCS7 (65Mbps, 72.2Mbps)		-71		dBm
Adjacent Channel Rejection				
OFDM, 6Mbps		37		dB
OFDM, 54Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

6 CPU, Memory and Interfaces

8.1 CPU

This chip embeds an ultra low power Micro 32-bit CPU, with 16-bit thumb mode. This CPU can be interfaced using:

- code RAM/ROM interface (iBus) that goes to the memory controller, that can also be used to access external flash memory,
- data RAM interface (dBus), that also goes to the memory controller
- AHB interface, for register access, and
- JTAG interface for debugging

8.2 Memory Controller

The memory controller contains ROM, and SRAM. It is accessed by the CPU using the iBus, dBus and AHB interface. Any of these interfaces can request access to the ROM or RAM modules, and the memory controller arbiters serve these 3 interfaces on a first-come-first-serve basis.

8.3 AHB and AHB Blocks

The AHB blocks performs the function of an arbiter, controls the AHB interfaces from the MAC, SDIO (host) and CPU. Depending on the address, the AHB data requests can go into one of the two slaves:

- APB block, or
- flash controller (usually for standalone applications).

Data requests to the memory controller are usually high speed requests, and requests to the APB block are usually register access.

The APB block acts as a decoder. It is meant only for access to programmable registers within ESP8266's main blocks. Depending on the address, the APB request can go to the radio, SI/SPI, SDIO (host), GPIO, UART, real-time clock (RTC), MAC or digital baseband.

8.4 Interfaces

The ESP8266 contains several analog and digital interfaces described in the following sections.

8.4.1 Master SI / SPI Control (Optional)

The master serial interface (SI) can operate in two, three or four-wire bus configurations to control the EEPROM or other I2C/SPI devices. Multiple I2C devices with different device addresses are supported by sharing the 2-wire bus.

Multiple SPI devices are supported by sharing the clock and data signals, using separate software controlled GPIO pins as chip selects.

The SPI can be used for controlling external devices such as serial flash memories, audio CODECs, or other slave devices. It is set up as a standard master SPI device with 3 different enable pins:

- SPI_EN0,
- SPI_EN1,
- SPI_EN2.

Both SPI master and SPI slave are supported with the latter being used as a host interface.

SPI_EN0 is used as an enable signal to an external serial flash memory for downloading patch code and/or MIB-data to the baseband in an embedded application. In a host based application, patch code and MIB-data can alternatively be downloaded via the host interface. This pin is active low and should be left open if not used.

SPI_EN1 is usually used for a user application, e.g. to control an external audio codec or sensor ADC, in an embedded application. This pin is active low and should be left open if not used.

SPI_EN2 usually controls an EEPROM to store individual data, such as MIB information, MAC address, and calibration data, or for general use. This pin is active low and should be left open if not used.

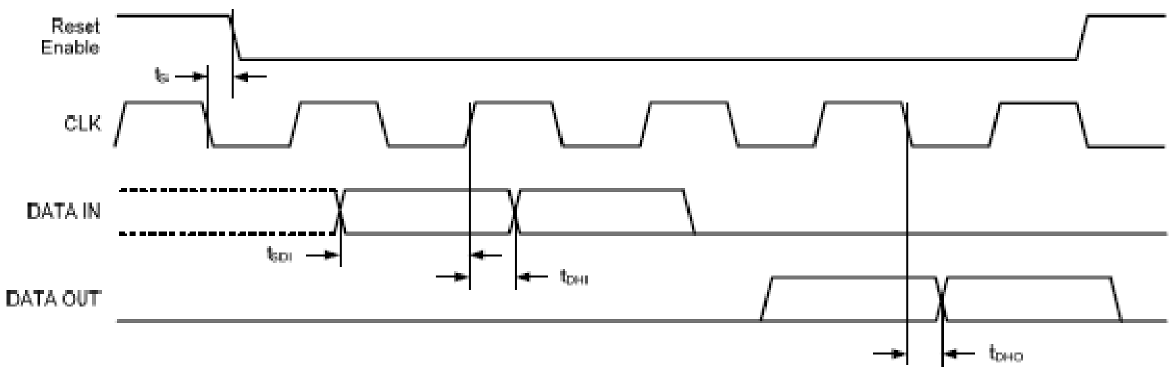


Figure 2: SPI timing characteristics

8.4.2 General Purpose IO

There are up to 16 GPIO pins. They can be assigned to various functions by the firmware. Each GPIO can be configured with internal pull-up/down, input available for sampling by a software register, input triggering an edge or level CPU interrupt, input triggering a level wakeup interrupt, open-drain or push-pull output driver, or output source from a software register, or a sigma-delta PWM DAC.

These pins are multiplexed with other functions such as host interface, UART, SI, Bluetooth coexistence, etc.

8.4.3 Digital IO Pads

The digital IO pads are bidirectional, non-inverting and tri-state. It includes input and an output buffer with tristate control inputs. Besides this, for low power operations, the IO can also be set to hold. For instance, when we power down the chip, all output enable signals can be set to hold low.

Optional hold functionality can be built into the IO if requested. When the IO is not driven by the internal or external circuitry, the hold functionality can be used to hold the state to the last used state.

The hold functionality introduces some positive feedback into the pad. Hence, the external driver that drives the pad must be stronger than the positive feedback. The required drive strength is however small – in the range of 5uA.

Parameter	Symbol	Min	Max	Unit
Input low voltage	V_{IL}	**-0.3**	$0.25\times V_{IO}$	**V**
Input high voltage	V_{IH}	$0.75\times VIO$	**3.6**	**V**
Input leakage current	I_{IL}		**50**	**nA**
Output low voltage	V_{OL}		$0.1\times V_{IO}$	**V**
Output high voltage	V_{OH}	$0.8\times VIO$		**V**
Input pin capacitance	C_{pad}		**2**	**pF**
VDDIO	V_{IO}	**1.7**	**3.6**	**V**
Maximum drive capability	I_{MAX}		**12**	**mA**
Temperature	T_{amb}	**-20**	**100**	**°C**

All digital IO pins are protected from over-voltage with a snap-back circuit connected between the pad and ground. The snap back voltage is typically about 6V, and the holding voltage is 5.8V. This provides protection from over-voltages and ESD. The output devices are also protected from reversed voltages with diodes.

7 Firmware & Software Development Kit

The application and firmware is executed in on-chip ROM and SRAM, which loads the instructions during wake-up, through the SDIO interface, from the external flash.

The firmware implements TCP/IP, the full 802.11 b/g/n/e/i WLAN MAC protocol and Wi-Fi Direct specification. It supports not only basic service set (BSS) operations under the distributed control function (DCF) but also P2P group operation compliant with the latest Wi-Fi P2P protocol. Low level protocol functions are handled automatically by ESP8266:

- **7.1** RTS/CTS,
- **7.2** acknowledgement,
- **7.3** fragmentation and defragmentation,
- **7.4** aggregation,
- **7.5** frame encapsulation (802.11h/RFC 1042),
- **7.6** automatic beacon monitoring / scanning, and
- **7.7** P2P Wi-Fi direct,

Passive or active scanning, as well as P2P discovery procedure is performed autonomously once initiated by the appropriate command. Power management is handled with minimum host interaction to minimize active duty period.

9.1 Features

The SDK includes the following library functions:

- 802.11 b/g/n/d/e/i/k/r support;
- Wi-Fi Direct (P2P) support:
- P2P Discovery, P2P Group Owner mode, P2P Power Management
- Infrastructure BSS Station mode / P2P mode / softAP mode support;
- Hardware accelerators for CCMP (CBC-MAC, counter mode), TKIP (MIC, RC4), WAPI (SMS4), WEP (RC4), CRC;

- WPA/WPA2 PSK, and WPS driver;
- Additional 802.11i security features such as pre-authentication, and TSN;
- Open Interface for various upper layer authentication schemes over EAP such as TLS, PEAP, LEAP, SIM, AKA, or customer specific;
- 802.11n support (2.4GHz / 5GHz);
- Supports MIMO 1×1 and 2×1, STBC, A-MPDU and A-MSDU aggregation and 0.4µs guard interval;
- WMM power save U-APSD;
- Multiple queue management to fully utilize traffic prioritization defined by 802.11e standard;
- UMA compliant and certified;
- 802.1h/RFC1042 frame encapsulation;
- Scattered DMA for optimal CPU off load on Zero Copy data transfer operations;
- Antenna diversity and selection (software managed hardware);
- Clock/power gating combined with 802.11-compliant power management dynamically adapted to curent connection condition providing minimal power consumption;
- Adaptive rate fallback algorithm sets the optimium transmission rate and Tx power based on actual SNR and packet loss information;
- Automatic retransmission and response on MAC to avoid packet discarding on slow host environment;
- Seamless roaming support;
- Configurable packet traffic arbitration (PTA) with dedicated slave processor based design provides flexible and exact timing Bluetooth co-existence supoport for a wide range of Bluetooth Chip vendors;
- Dual and single antenna Bluetooth co-existence support with optional simultaneous receive (Wi-Fi/Bluetooth) capability.

8 Power Management

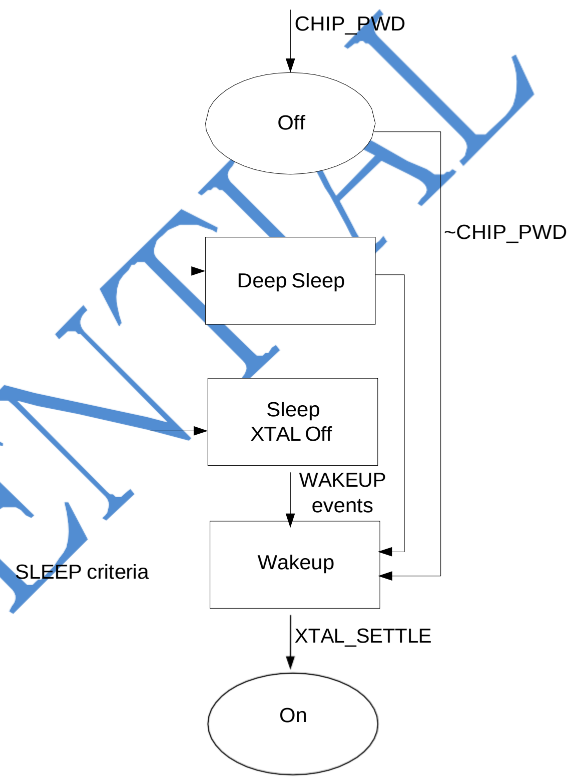
The chip can be put into the following states:

8.1 OFF: CHIP_PD pin is low. The RTC is disabled. All registers are cleared.

8.2 DEEP_SLEEP: Only RTC is powered on – the rest of the chip is powered off. Recovery memory of RTC can keep basic Wi-Fi connecting information.

8.3 SLEEP: Only the RTC is operating. The crystal oscillator is disabled. Any wakeup events (MAC, host, RTC timer, external interrupts) will put the chip into the WAKEUP state.

8.4 WAKEUP: In this state, the system goes from the sleep states to the PWR state. The crystal oscillator and PLLs are enabled.



8.5 ON state: the high speed clock is operational and sent to each block enabled by the clock control register. Lower level clock gating is implemented at the block level, including the CPU, which can be gated off using the WAITI instruction, while the system is on.

9 Clock Management

11.1 High Frequency Clock

The high frequency clock on ESP8266 is used to drive both the Tx and Rx mixers. This clock is generated from the internal crystal oscillator and an external crystal. The crystal frequency can range from 26MHz to 52MHz.

While internal calibration of the crystal oscillator ensures that a wide range of crystals can be used, in general, the quality of the crystal is still a factor to consider, to obtain reasonable phase noise. When the crystal selected is sub-optimal due to large frequency drifts or poor Q-factor, the maximum throughput and sensitivity of the Wi-Fi system is degraded. Please refer to the application notes on how the frequency offset can be measured.

Parameter	Symbol	Min	Max	Unit
Frequency	F_{XO}	26	52	MHz
Loading capacitance	C_L		32	pF
Motional capacitance	C_M	2	5	pF
Series resistance	R_S	0	65	Ω
Frequency tolerance	ΔF_{XO}	-15	15	ppm
Frequency vs temperature (-25°C ~ 75°C)	$\Delta F_{XO,Temp}$	-15	15	ppm

11.2 External Reference Requirements

For an externally generated clock, the frequency can range from 26MHz to 52MHz can be used.

For good performance of the radio, the following characteristics are expected of the clock:

Parameter	Symbol	Min	Max	Unit
Clock amplitude	V_{XO}	0.2	1	Vpp
External clock accuracy	$\Delta F_{XO,EXT}$	-15	15	ppm
Phase noise @1kHz offset, 40MHz clock			-120	dBc/Hz
Phase noise @10kHz offset, 40MHz clock			-130	dBc/Hz
Phase noise @100kHz offset, 40MHz clock			-138	dBc/Hz

10 Radio

The ESP8266 radio consists of the following main blocks:

10.1 2.4GHz receiver

10.2 2.4GHz transmitter

10.3 High speed clock generators and crystal oscillator

10.4 Real time clock

10.5 Bias and regulators

10.6 Power management

12.1 Channel Frequencies

The RF transceiver supports the following channels according to the IEEE802.11bgn standards.

Channel No	Frequency (MHz)	Channel No	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	12	2467
6	2437	13	2472
7	2442	14	2484

12.2 2.4GHz Receiver

The 2.4GHz receiver downconverts the RF signal to quadrature baseband signals and converts them to the digital domain with 2 high resolution high speed ADCs. To adapt to varying signal channel conditions, RF filters, automatic gain control, DC offset cancelation circuits and baseband filters are integrated within the radio.

12.3 2.4GHz Transmitter

The 2.4GHz transmitter upconverts the quadrature baseband signals to 2.4GHz, and drives the antenna with a high powered CMOS power amplifier. The use of digital calibration further improves the linearity of the power amplifier, enabling a state of art performance of delivering +19dBm average power for 802.11b transmission and +16dBm for 802.11n transmission.

Additional calibrations are integrated to cancel any imperfections of the radio, such as:

- carrier leakage,
- I/Q phase matching, and
- baseband nonlinearities

This reduces the amount of time required and test equipment required for production testing.

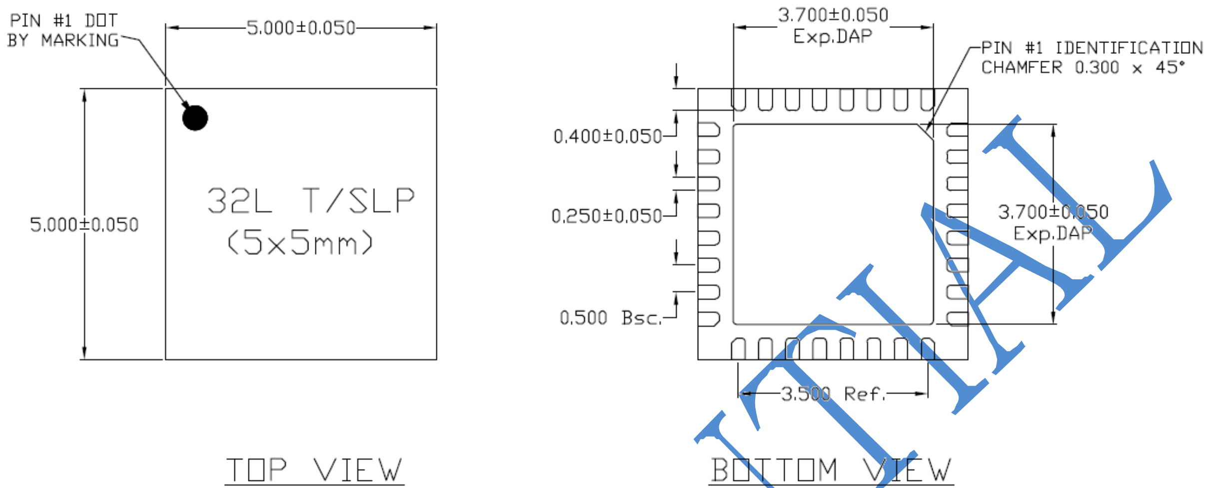
12.4 Clock Generator

The clock generator generates quadrature 2.4GHz clock signals for the receiver and transmitter. All components of the clock generator are integrated on-chip, including:

- inductor,
- varactor, and
- loop filter.

The clock generator has built-in calibration and self test circuits. Quadrature clock phases and phase noise are optimized on-chip with patented calibration algorithms to ensure the best receiver and transmitter performance.

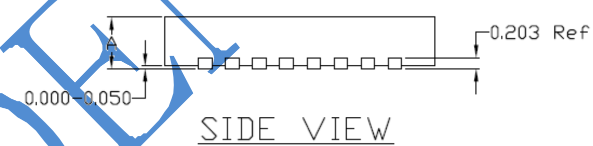
App. QFN32 Package Drawing



NOTE:

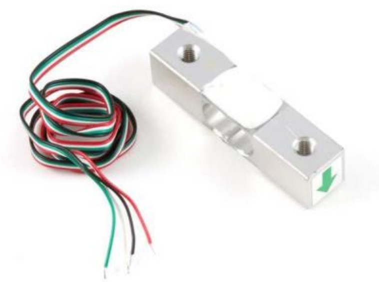
1) TSLP AND SLP SHARE THE SAME EXPOSE OUTLINE BUT WITH DIFFERENT THICKNESS:

		TSLP	SLP
A	MAX.	0.800	0.900
	NOM.	0.750	0.850
	MIN.	0.700	0.800



Datasheet

3133 - Micro Load Cell (0-5kg) - CZL635



Contents

What do you have to know?

A load cell is a force sensing module - a carefully designed metal structure, with small elements called strain gauges mounted in precise locations on the structure. Load cells are designed to measure a specific force, and ignore other forces being applied. The electrical signal output by the load cell is very small and requires specialized amplification. Fortunately, **the 1046 PhidgetBridge will perform all the amplification and measurement of the electrical output.**

Load cells are designed to measure force in one direction. They will often measure force in other directions, but the sensor sensitivity will be different, since parts of the load cell operating under compression are now in tension, and vice versa.

How does it work - For curious people

Strain-gauge load cells convert the load acting on them into electrical signals. The measuring is done with very small resistor patterns called strain gauges - effectively small, flexible circuit boards. The gauges are bonded onto a beam or structural member that deforms when weight is applied, in turn deforming the strain-gauge. As the strain gauge is deformed, it's electrical resistance changes in proportion to the load.

The changes to the circuit caused by force is much smaller than the changes caused by variation in temperature. Higher quality load cells cancel out the effects of temperature using two techniques. By matching the expansion rate of the strain gauge to the expansion rate of the metal it's mounted on, undue strain on the gauges can be avoided as the load cell warms up and cools down. The most important method of temperature compensation involves using multiple strain gauges, which all respond to the change in temperature with the same change in resistance. Some load cell designs use gauges which are never subjected to any force, but only serve to counterbalance the temperature effects on the gauges that measuring force. Most designs use 4 strain gauges, some in compression, some under tension, which maximizes the sensitivity of the load cell, and automatically cancels the effect of temperature.

Installation

This Single Point Load Cell is used in small jewelry scales and kitchen scales. It's mounted by bolting down the end of the load cell where the wires are attached, and applying force on the other end **in the direction of the arrow.** Where the force is applied is not critical, as this load cell measures a shearing effect on the beam, not the bending of the beam. If you mount a small platform on the load cell, as would be done in a small scale, this load cell provides accurate readings regardless of the position of the load on the platform.

Calibration

You can use this simple formula to convert the measured mv/V output from the load cell to the measured force:

Expected Force/Weight = K * (Measured mV/V - Offset)

Where K is gain value that will change depending on what unit of force or weight you want to measure. Since the offset varies between individual load cells, it’s necessary to measure it for each sensor. Record the output of the load cell at rest on a flat surface with no force on it. The mv/V output measured by the PhidgetBridge is the offset.

Once you’ve found the offset, measure something with a known weight and solve the equation for K. You can also calibrate the load cell at multiple known weights and use these points to model a linear function.

Product Specifications	
Mechanical	
Housing Material	Aluminum Alloy
Load Cell Type	Strain Gauge
Capacity	5kg
Dimensions	55.25x12.7x12.7mm
Mounting Holes	M5 (Screw Size)
Cable Length	550mm
Cable Size	30 AWG (0.2mm)
Cable - no. of leads	4
Electrical	
Precision	0.05%
Rated Output	1.0±0.15 mv/V
Non-Linearity	0.05% FS
Hysteresis	0.05% FS
Non-Repeatability	0.05% FS
Creep (per 30 minutes)	0.1% FS
Temperature Effect on Zero (per 10°C)	0.05% FS
Temperature Effect on Span (per 10°C)	0.05% FS
Zero Balance	±1.5% FS
Input Impedance	1130±10 Ohm
Output Impedance	1000±10 Ohm
Insulation Resistance (Under 50VDC)	≥5000 MOhm
Excitation Voltage	5 VDC
Compensated Temperature Range	-10 to ~+40°C
Operating Temperature Range	-20 to ~+55°C
Safe Overload	120% Capacity
Ultimate Overload	150% Capacity

Glossary

Capacity
The maximum load the load cell is designed to measure within its specifications.

Creep
The change in sensor output occurring over 30 minutes, while under load at or near capacity and with all environmental conditions and other variables remaining constant.

FULL SCALE or FS
Used to qualify error - FULL SCALE is the change in output when the sensor is fully loaded. If a particular error (for example, Non-Linearity) is expressed as 0.1% F.S., and the output is 1.0mV/V, the maximum non-linearity that will be seen over the operating range of the sensor will be 0.001 mV/V. An important distinction is that this error doesn't have to only occur at the maximum load. If you are operating the sensor at a maximum of 10% of capacity, for this example, the non-linearity would still be 0.001mV/V, or 1% of the operating range that you are actually using.

Hysteresis
If a force equal to 50% of capacity is applied to a load cell which has been at no load, a given output will be measured. The same load cell is at full capacity, and some of the force is removed, resulting in the load cell operating at 50% capacity. The difference in output between the two test scenarios is called hysteresis.

Excitation Voltage
Specifies the voltage that can be applied to the power/ground terminals on the load cell. In practice, if you are using the load cell with the PhidgetBridge, you don't have to worry about this spec.

Input Impedance
Determines the power that will be consumed by the load cell. The lower this number is, the more current will be required, and the more heating will occur when the load cell is powered. In very noisy environments, a lower input impedance will reduce the effect of Electromagnetic interference on long wires between the load cell and PhidgetBridge.

Insulation Resistance
The electrical resistance measured between the metal structure of the load cell, and the wiring. The practical result of this is the metal structure of the load cells should not be energized with a voltage, particularly higher voltages, as it can arc into the PhidgetBridge. Commonly the load cell and the metal framework it is part of will be grounded to earth or to your system ground.

Maximum Overload
The maximum load which can be applied without producing a structural failure.

Non-Linearity
Ideally, the output of the sensor will be perfectly linear, and a simple 2-point calibration will exactly describe the behaviour of the sensor at other loads. In practice, the sensor is not perfect, and Non-linearity describes the maximum deviation from the linear curve. Theoretically, if a more complex calibration is used, some of the non-linearity can be calibrated out, but this will require a very high accuracy calibration with multiple points.

Non-Repeatability
The maximum difference the sensor will report when exactly the same weight is applied, at the same temperature, over multiple test runs.

Operating Temperature
The extremes of ambient temperature within which the load cell will operate without permanent adverse change to any of its performance characteristics.

Output Impedance
Roughly corresponds to the input impedance. If the Output Impedance is very high, measuring the bridge will distort the results. The PhidgetBridge carefully buffers the signals coming from the load cell, so in practice this is not a concern.

Rated Output
Is the difference in the output of the sensor between when it is fully loaded to its rated capacity, and when it's unloaded. Effectively, it's how sensitive the sensor is, and corresponds to the gain calculated when calibrating the sensor. More expensive sensors have an exact rated output based on an individual calibration done at the factory.

Safe Overload
The maximum axial load which can be applied without producing a permanent shift in performance characteristics beyond those specified.

Compensated Temperature
The range of temperature over which the load cell is compensated to maintain output and zero balance within specified limits.

Temperature Effect on Span
Span is also called rated output. This value is the change in output due to a change in ambient temperature. It is measured over 10 degree C temperature interval.

Temperature Effect on Zero
The change in zero balance due to a change in ambient temperature. This value is measured over 10 degree C temperature interval.

Zero Balance
Zero Balance defines the maximum difference between the +/- output wires when no load is applied. Realistically, each sensor will be individually calibrated, at least for the output when no load is applied. Zero Balance is more of a concern if the load cell is being interfaced to an amplification circuit - the PhidgetBridge can easily handle enormous differences between +/-. If the difference is very large, the PhidgetBridge will not be able to use the higher Gain settings.

24-Bit Analog-to-Digital Converter (ADC) for Weigh Scales

DESCRIPTION

Based on Avia Semiconductor's patented technology, HX711 is a precision 24-bit analog- to-digital converter (ADC) designed for weigh scales and industrial control applications to interface directly with a bridge sensor.

The input multiplexer selects either Channel A or B differential input to the low-noise programmable gain amplifier (PGA). Channel A can be programmed with a gain of 128 or 64, corresponding to a full-scale differential input voltage of ±20mV or ±40mV respectively, when a 5V supply is connected to AVDD analog power supply pin. Channel B has a fixed gain of 32. On-chip power supply regulator eliminates the need for an external supply regulator to provide analog power for the ADC and the sensor. Clock input is flexible. It can be from an external clock source, a crystal, or the on-chip oscillator that does not require any external component. On-chip power-on-reset circuitry simplifies digital interface initialization.

There is no programming needed for theinternal registers. All controls to the HX711 are through the pins.

FEATURES

- **Two selectabel differential input channels**
- **On-chip active low noise PGA with selectabel gain of 32, 64 and 128**
- **On-chip power supply regulator for load-cell and ADC analog power supply**
- **On-chip oscillator requiring no external component with optional external crystal**
- **On-chip power-on-reset**
- **Simple digital control and serial interface: pin-driven controls, no programming needed**
- **Selectabel 10SPS or 80SPS output data rate**
- **Simultaneous 50 and 60Hz supply rejection**
- **Current consumption including on-chip analog power supply regulator:**

  normal operation < 1.5mA, power down < 1uA
- **Operation supply voltage range: 2.6 ~ 5.5V**
- **Operation temperature range: -40 ~ +85℃**
- **16 pin SOP-16 package**

APPLICATIONS

- **Weigh Scales**
- **Industrial Process Control**

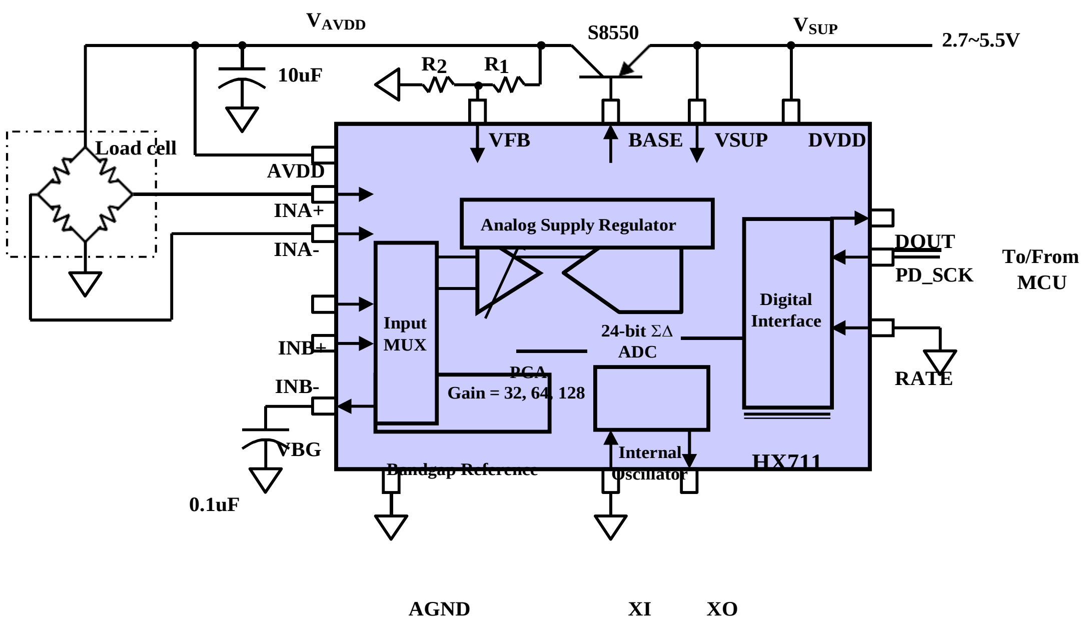
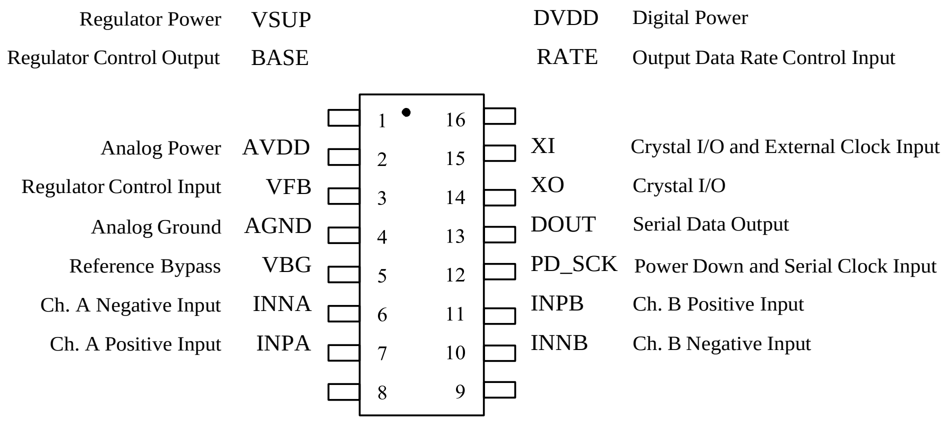


Fig. 1 Typical weigh scale application block diagram

TEL: (592) 252-9530 (P. R. China)
EMAIL: market@aviaic.com

Pin Description



SOP-16L Package

Pin #	Name	Function	Description
1	VSUP	Power	Regulator supply: 2.7 ~ 5.5V
2	BASE	Analog Output	Regulator control output（NC when not used）
3	AVDD	Power	Analog supply: 2.6 ~ 5.5V
4	VFB	Analog Input	Regulator control input（connect to AGND when not used）
5	AGND	Ground	Analog Ground
6	VBG	Analog Output	Reference bypass output
7	INA-	Analog Input	Channel A negative input
8	INA+	Analog Input	Channel A positive input
9	INB-	Analog Input	Channel B negative input
10	INB+	Analog Input	Channel B positive input
11	PD_SCK	Digital Input	Power down control (high active) and serial clock input
12	DOUT	Digital Output	Serial data output
13	XO	Digital I/O	Crystal I/O (NC when not used）
14	XI	Digital Input	Crystal I/O or external clock input, 0: use on-chip oscillator
15	RATE	Digital Input	Output data rate control, 0: 10Hz; 1: 80Hz
16	DVDD	Power	Digital supply: 2.6 ~ 5.5V

Tabel 1 Pin Description

KEY ELECTRICAL CHARACTERISTICS

Parameter	Notes	MIN	TYP	MAX	UNIT
Full scale differential input range	V(inp)-V(inn)		±0.5(AVDD/GAIN)		V
Common mode input		AGND+1.2		AVDD-1.3	V
Output data rate	Internal Oscillator, RATE = 0		10		Hz
	Internal Oscillator, RATE = DVDD		80		
	Crystal or external clock, RATE = 0		f_{clk}/1,105,920		
	Crystal or external clock, RATE = DVDD		f_{clk}/138,240		
Output data coding	2's complement	800000		7FFFFF	HEX
Output settling time (1)	RATE = 0		400		ms
	RATE = DVDD		50		
Input offset drift	Gain = 128		0.2		mV
	Gain = 64		0.4		
Input noise	Gain = 128， RATE = 0		50		nV(rms)
	Gain = 128， RATE = DVDD		90		
Temperature drift	Input offset（Gain = 128）		±6		nV/℃
	Gain（Gain = 128）		±5		ppm/℃
Input common mode rejection	Gain = 128， RATE = 0		100		dB
Power supply rejection	Gain = 128， RATE = 0		100		dB
Reference bypass（V_{BG}）			1.25		V
Crystal or external clock frequency		1	11.0592	20	MHz
Power supply voltage	DVDD	2.6		5.5	V
	AVDD，VSUP	2.6		5.5	
Analog supply current (including regulator)	Normal		1400		µA
	Power down		0.3		
Digital supply current	Normal		100		µA
	Power down		0.2		

（1）Settling time refers to the time from power up, reset, input channel change and gain change to valid stabel output data.

Tabel 2 Key Electrical Characteristics

Analog Inputs

Channel A differential input is designed to interface directly with a bridge sensor's differential output. It can be programmed with a gain of 128 or 64. The large gains are needed to accommodate the small output signal from the sensor. When 5V supply is used at the AVDD pin, these gains correspond to a full-scale differential input voltage of ±20mV or ±40mV respectively.

Channel B differential input has a fixed gain of 32. The full-scale input voltage range is ±80mV, when 5V supply is used at the AVDD pin.

Power Supply Options

Digital power supply (DVDD) should be the same power supply as the MCU power supply.

When using internal analog supply regulator, the dropout voltage of the regulator depends onthe external transistor used. The output voltage is equal to $V_{AVDD}=V_{BG}*(R1+R2)/R1$ (Fig. 1). This voltage should be designed with a minimum of 100mV below VSUP voltage.

If the on-chip analog supply regulator is notused, the VSUP pin should be connected to either AVDD or DVDD, depending on which voltage is higher. Pin VFB should be connected to Ground and pin BASE becomes NC. The external 0.1uF bypass capacitor shown on Fig. 1 at the VBG output pin is then not needed.

Clock Source Options

By connecting pin XI to Ground, the on-chip oscillator is activated. The nominal output data rate when using the internal oscillator is 10 (RATE=0) or 80SPS (RATE=1).

If accurate output data rate is needed, crystal or external reference clock can be used. A crystal can be directly connected across XI and XO pins. An external clock can be connected to XI pin, through a 20pF ac coupled capacitor. This external clock is not required to be a square wave.It can come directly from the crystal output pin of the MCU chip, with amplitude as low as 150 mV.

When using a crystal or an external clock, the internal oscillator is automatically powered down.

Output Data Rate and Format

When using the on-chip oscillator, output data rate is typically 10 (RATE=0) or 80SPS(RATE=1).

When using external clock or crystal, outputdata rate is directly proportional to the clock or crystal frequency. Using 11.0592MHz clock or crystal results in an accurate 10 (RTE=0) or 80SPS (RATE=1) output data rate.

The output 24 bits of data is in 2's complement format. When input differential signal goes out of the 24 bit range, the output data will be saturated at 800000h (MIN) or 7FFFFFh (MAX), until the input signal comes back to the input range.

Serial Interface

Pin PD_SCK and DOUT are used for data retrieval, input selection, gain selection and power down controls.

When output data is not ready for retrieval, digital output pin DOUT is high. Serial clock input PD_SCK should be low. When DOUT goesto low, it indicates data is ready for retrieval. By applying 25~27 positive clock pulses at the PD_SCK pin, data is shifted out from the DOUT output pin. Each PD_SCK pulse shifts out one bit, starting with the MSB bit first, until all 24 bits are shifted out. The 25^{th} pulse at PD_SCK input will pull DOUT pin back to high (Fig.2).

Input and gain selection is controlled by the number of the input PD_SCK pulses (Tabel 3). PD_SCK clock pulses should not be less than 25 or more than 27 within one conversion period, to avoid causing serial communication error.

PD_SCK Pulses	Input channel	Gain
25	A	128
26	B	32
27	A	64

Tabel 3 Input Channel and Gain Selection

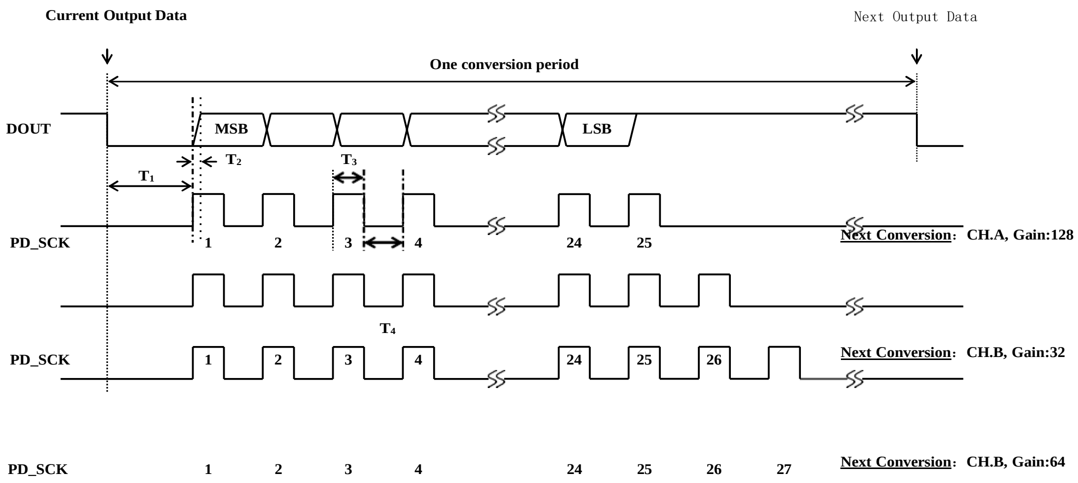


Fig.2 Data output, input and gain selection timing and control

Symbol	Note	MIN	TYP	MAX	Unit
T_1	DOUT falling edge to PD_SCK rising edge	0.1			µs
T_2	PD_SCK rising edge to DOUT data ready			0.1	µs
T_3	PD_SCK high time	0.2	1	50	µs
T_4	PD_SCK low time	0.2	1		µs

Reset and Power-Down

When chip is powered up, on-chip power on rest circuitry will reset the chip.

Pin PD_SCK input is used to power down the HX711. When PD_SCK Input is low, chip is in normal working mode.

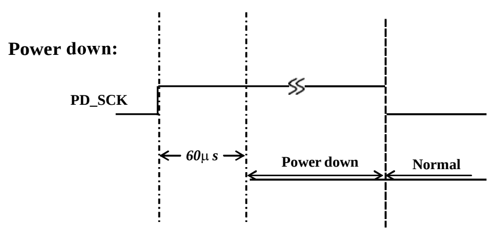


Fig.3 Power down control

When PD_SCK pin changes from low to high and stays at high for longer than 60µs, HX711enters power down mode (Fig.3). When internal regulator is used for HX711 and the external transducer, both HX711 and the transducer will be powered down. When PD_SCK returns to low, chip will reset and enter normal operation mode.

After a reset or power-down event, input selection is default to Channel A with a gain of 128.

Application Example

Fig.1 is a typical weigh scale application using HX711. It uses on-chip oscillator (XI=0), 10Hz output data rate (RATE=0). A Single power supply（2.7～5.5V） comes directly from MCU power supply. Channel B can be used for battery level detection. The related circuitry is not shown on Fig. 1.

Reference PCB Board (Single Layer)

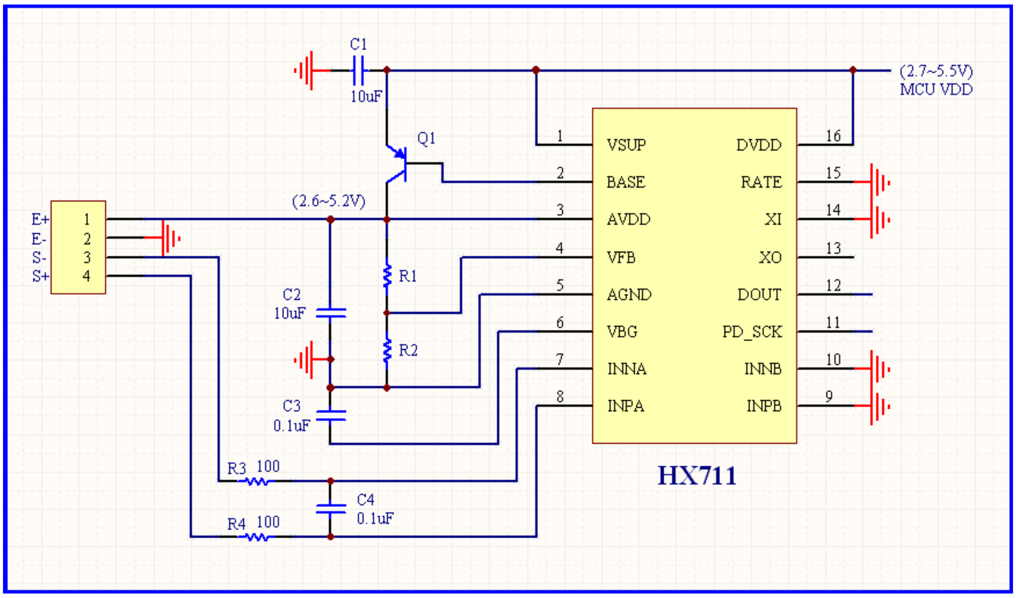


Fig.4 Reference PCB board schematic

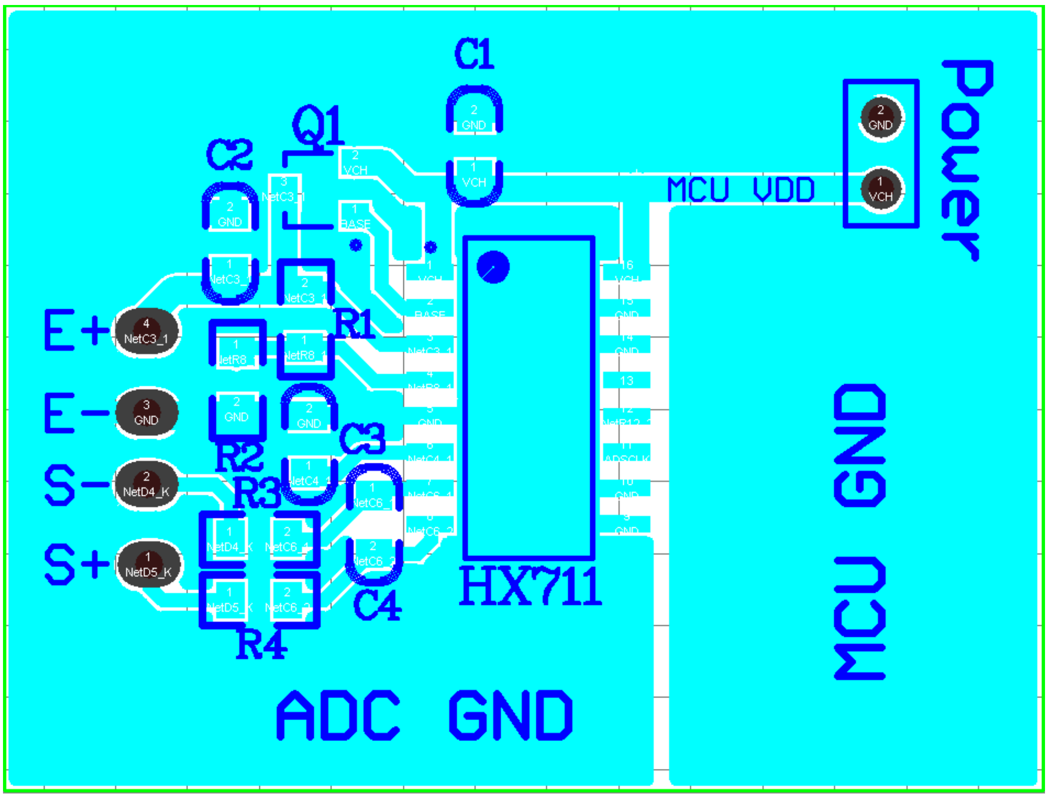


Fig.5 Reference PCB board layout

Reference Driver (Assembly)

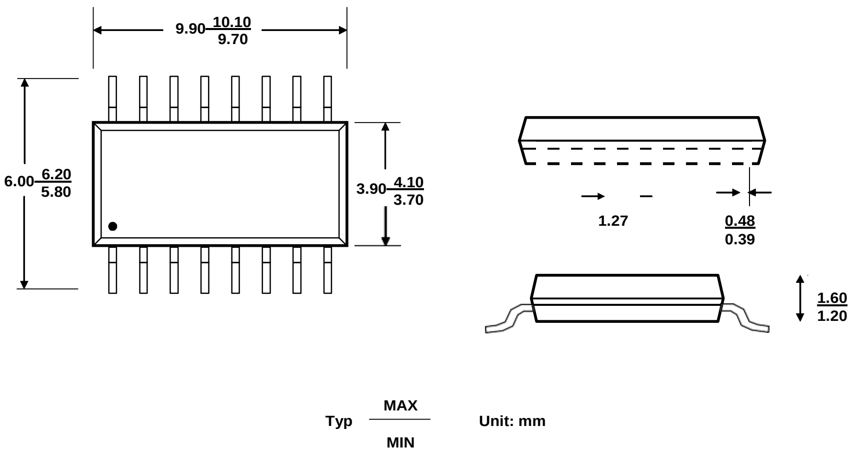
```
/*---------------------------------------------------------------------------------------------------------
Call from ASM:       LCALL    ReaAD
Call from C:     extern unsigned long ReadAD(void);
                    .
                    .
                   unsigned long data;
                   data=ReadAD();
                    .
                    .
-----------------------------------------------------------------------------------------------------------*/
PUBLIC          ReadAD
HX711ROM        segment  code
rseg            HX711ROM

sbit            ADDO = P1.5;
sbit            ADSK = P0.0;
/*-----------------------------------------------------------------------------------
 OUT:    R4, R5, R6, R7    R7=>LSB
-----------------------------------------------------------------------------------*/
ReadAD:
    CLR     ADSK                //AD Enable (PD_SCK set low)
    SETB    ADDO                //Enable 51CPU I/0
    JB      ADDO,$              //AD conversion completed?
    MOV     R4,#24
ShiftOut:
    SETB    ADSK                //PD_SCK set high (positive pulse)
    NOP
    CLR     ADSK                //PD_SCK set low
    MOV     C,ADDO              //read on bit
    XCH     A,R7                //move data
    RLC     A
    XCH     A,R7
    XCH     A,R6
    RLC     A
    XCH     A,R6
    XCH     A,R5
    RLC     A
    XCH     A,R5
    DJNZ    R4,ShiftOut          //moved 24BIT?
    SETB    ADSK
    NOP
    CLR     ADSK
    RET
    END
```

Reference Driver（C）

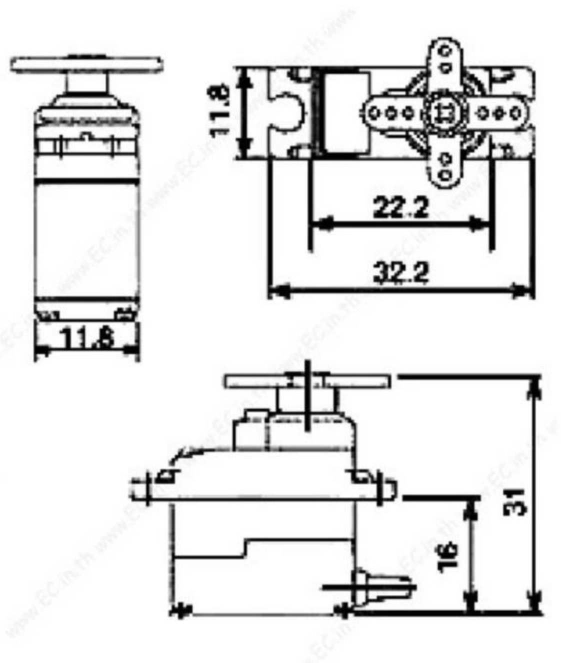
```
//-------------------------------------------------------------------------------------------------------------------------------------
sbit   ADDO = P1^5;
sbit   ADSK = P0^0;
unsigned long ReadCount(void){
  unsigned long Count;
  unsigned char i;
  ADDO=1;
  ADSK=0;
  Count=0;
  while(ADDO);
  for (i=0;i<24;i++){
    ADSK=1;
    Count=Count<<1;
    ADSK=0;
    if(ADDO) Count++;
  }
  ADSK=1;
  Count=Count^0x800000;
  ADSK=0;
  return(Count);
}
```

Package Dimensions



SOP-16L Package

SG90 9 g Micro Servo



Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but *smaller*. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.

Specifications

- Weight: 9 g
- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 1.8 kgf·cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs
- Temperature range: 0 ºC – 55 ºC

Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is all the way to the left. ms pulse) is all the way to the right, ""-90" (~1ms pulse) is all the way to the left.

TowerPro SG90 - Micro Servo

Basic Information

Modulation: Analog

Torque: **4.8V:** 25.0 oz-in (1.80 kg-cm)

Speed: **4.8V:** 0.10 sec/60°

Weight: 0.32 oz (9.0 g)

Dimensions:

Length: 0.91 in (23.1 mm)

Width: 0.48 in (12.2 mm)

Height:1.14 in (29.0 mm)

Motor Type: 3-pole
Gear Type: Plastic
Rotation/Support: Bushing

Additional Specifications

Rotational Range:180°
Pulse Cycle: ca. 20 ms
Pulse Width: 500-2400 µs

T-Pro Mini Servo SG-90 9G Servo

The **TP SG90** is similar in size and weight to the Hitec HS-55, and is a good choice for most park flyers and helicopters. Hobbyists from around the world has used the SG90 on famous planes like GWS Slow Stick, E-Flite Airplanes, Great Planes, Thunder Tiger, Align, EDF jets and more. If you are looking for a servo that won't break your arm or leg, this is the perfect choice for you!

The **TP SG90** servo weighs 0.32 ounces (9.0 grams). Total weight with wire and connector is 0.37 ounces (10.6 grams).

The **TP SG90** has the universal "S" type connector that fits most receivers, including Futaba, JR, GWS, Cirrus, Blue Bird, Blue Arrow, Corona, Berg and Hitec.

The wire colors are **Red = Battery(+)** **Brown = Battery(-)** **Orange = Signal**

TP SG90 Specifications:

Dimensions (L x W x H) = 0.86 x 0.45 x 1.0 inch (22.0 x 11.5 x 27 mm)

Weight = 0.32 ounces (9 grams)

Weight with wire and connecter = 0.37 ounce (10.6 grams)

Stall Torque at 4.8 volts = 16.7 oz/in (1.2 kg/cm)

Operating Voltage = 4.0 to 7.2 volts

Operating Speed at 4.8 volts (no load) = 0.12 sec/ 60 degrees

Connector Wire Length = 9.75 inches (248 mm)

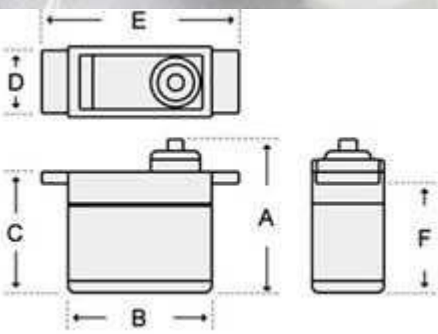
Universal "S" type connector fits most receivers

9g Tower Pro Servo

Tower Pro 9g servo
These Micro strong and made to last, great for planes. The servos include 3 servo arms.
Specs:

- DIMENSION: 26mm*13mm*24mm
- WEIGHT: 9G
- OPERATING SPEED: 0.12sec/60degree(4.8V);0.11sec/60degree(6V)
- STALL TORQUE: 1.2kg/cm or 17oz-in. (4.8V) 1.6kg/cm or 22oz-in.(6.0V)
- OPERATING VOLTAGE: 4.8V~6.0V
- FEATURE: 3 pole wire, all nylon gear, connector wire length: 15cm

Usage Type :	
Voltage (V) :	4.8,6.0
Speed@4.8V (sec/60 :	0.12
Torque@4.8V (kg-cm) :	1.2
Speed@6.0V (sec/60 :	0.11
Torque@6.0V (kg-cm) :	1.6
Weight (g) :	9
Dimension B (mm) :	26
Dimension C (mm) :	24
Dimension D (mm) :	13



The TG9e boasts the same performance as other servo's 10x the price with a .10sec travel time and up to 1.5kg in torque and an ultra narrow dead bandwidth!

The TG9e performance is on par with the famous HXT900, however the TG9e isn't as resistant to crashes or over-loading.

Please always ensure your control surfaces are bind free.

Spec.

Dimension: 23x12.2x29mm

Torque: 1.5kg/cm (4.8V)

Operating speed: 0.10sec/60 degree 0.09sec/60 degree(6.0V)

Operating voltage: 4.8V

Temperature range: 0-55C

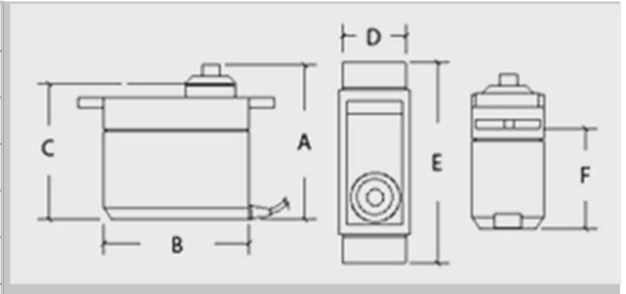
Dead band-width: 7us

Lead Length: 260mm

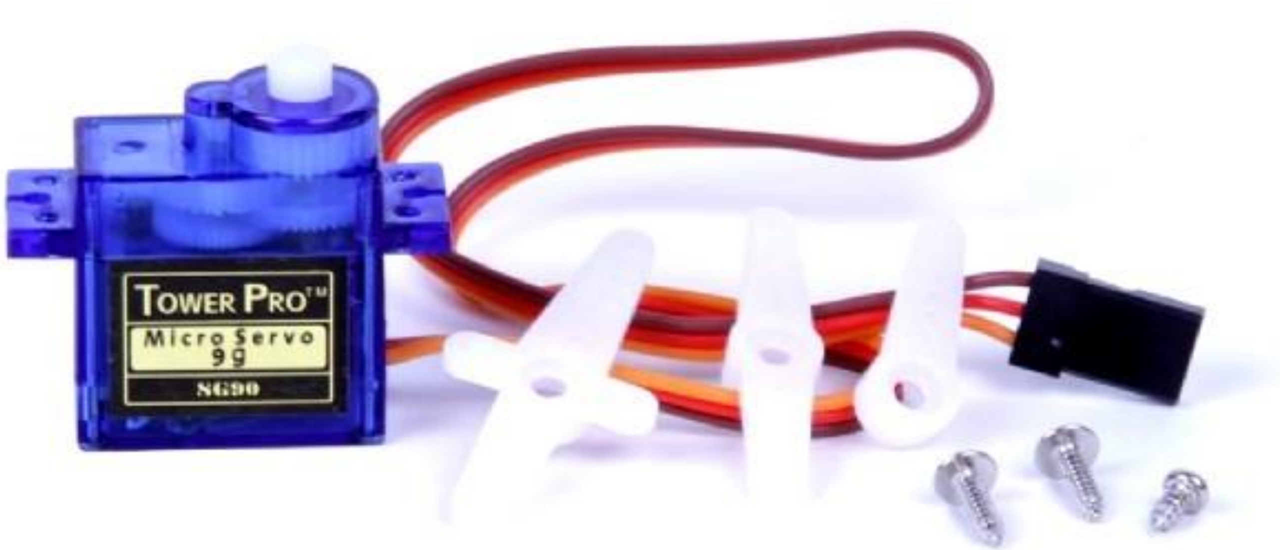
Important.
The TG9e does not have the same strength and longevity as the HXT900.

Please ensure your control surfaces are bind-free and always check servos after a hard landing or crash!

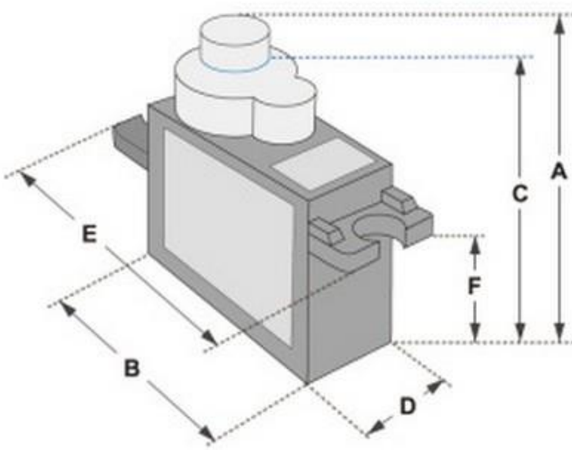
Weight (g)	9
Torque (kg)	1.5
Speed(Sec/60deg)	0.09
A(mm)	30
B(mm)	23
C(mm)	27
D(mm)	12
E(mm)	33
F(mm)	16



SERVO MOTOR SG90 DATA SHEET



Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.



Dimensions & Specifications
A (mm) : 32
B (mm) : 23
C (mm) : 28.5
D (mm) : 12
E (mm) : 32
F (mm) : 19.5
Speed (sec) : 0.1
Torque (kg-cm) : 2.5
Weight (g) : 14.7
Voltage : 4.8 - 6

Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is middle, is all the way to the right, "-90" (~1ms pulse) is all the way to the left.