TGAT Datasheet

May 18, 2016

NeuroSky
Brain-Computer Interface Technologies

The NeuroSky® product families consist of hardware and software components for simple integration of this biosensor technology into consumer and industrial end-applications. All products are designed and manufactured to meet consumer thresholds for quality, pricing, and feature sets. NeuroSky sets itself apart by providing building block component solutions that offer friendly synergies with related and complementary technological solutions.

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Product Overview

NeuroSky's ThinkGear-AT1 is the world first consumer grade single chip Electroencephalography (EEG) sensor designed for mass consumer applications. The following features are designed to allow customers to design a device in a form factor, user friendliness and price point necessary for success in mass markets like toy, video game and consumer wellness.

Features

- Single chip fully self-contained integrated bio-sensor
- Directly connect to dry electrode needed for mass market applications (as opposed to conventional medical wet sensors)
- Advanced on-chip filtering technology with high noise immunity
- Pin selectable AC noise filtering for various continental power grids
- Senses one channel EEG signal in real time and outputs it with 12 bit precision
- On-chip real-time EEG signal quality analysis and output of poor quality warning
- On-chip real-time processing and output of EEG power spectrums
- On-chip real-time processing and output of NeuroSky proprietary eSense meter for Attention and Meditation
- All data output via standard UART serial interface with programmable baud rates
- Various output enable/disable with pin setting and UART command
- Boundary-Scan Testing in Compliance with IEEE Standard 1149.1 (JTAG)
- On-chip regulator to enable single power sourcing
- Low power consumption suitable for portable wearable battery-driven applications

Electrical Specification

General

Classification	Specification	Notes
Product Family	ThinkGear-AT	A = ASIC, T = Toy
Model Number	TGAT	
Revision Number	1.0	
Dimension (Max)	9 x 9 x 1.6mm	354 x 354 x 63mils (L x W x H)
PCB Package	LQFP64	
Operating Voltage	2.97VDC ~ 3.63VDC	
Max DC Supply Voltage Noise	10mV Peak to Peak	
Max Power Consumption	15mA @ 3.3VDC	
ESD Protection	4kV Contact Discharge 8kV Air Discharge	Using external diodes
Output Interface Standard	UART(Serial)	TX, RX, VCC(+), GND(-)
Output Baud Rate	1200, 9600, 57600	Configurable
#EEG Channels	1	3 contacts (EEG, REF, GND)
Sampling Frequency	512 Samples per second	
Frequency Range	3 to 100Hz	

Absolute Maximum Ratings

Pin Name	Pin Definition	Min	Max	Unit
VCC33	DC Supply Voltage	0.5	3.63	VDC

Parameter	Min	Max	Unit
Analog I/O Input Voltage	0	2.3	VDC
Digital I/O Input Voltage	0	3.63	VDC
Storage Temperature	-65	125	Deg. C
Junction Temperature	-50	150	Deg. C

Recommended Operating Conditions

Parameter	Min	Max	Unit
Ambient Temperature	0	70	Deg. C
DC Supply Voltage (VCC33)	2.97	3.63	VDC
Max DC Supply Voltage Noise		10	mV pk-pk

Electrical Characteristics

Parameter	Min	Max	Unit
Operating Current Consumption (Idd)		15	mADC
Allowed Skin Impedance		20	MOhms
Overall Chip Amplification	65.1	66.8	dB
Band Pass Cutoff	3		dB
Notch Filter Attenuation	34.7	45.1	dB

IO Pins

Pin Designations

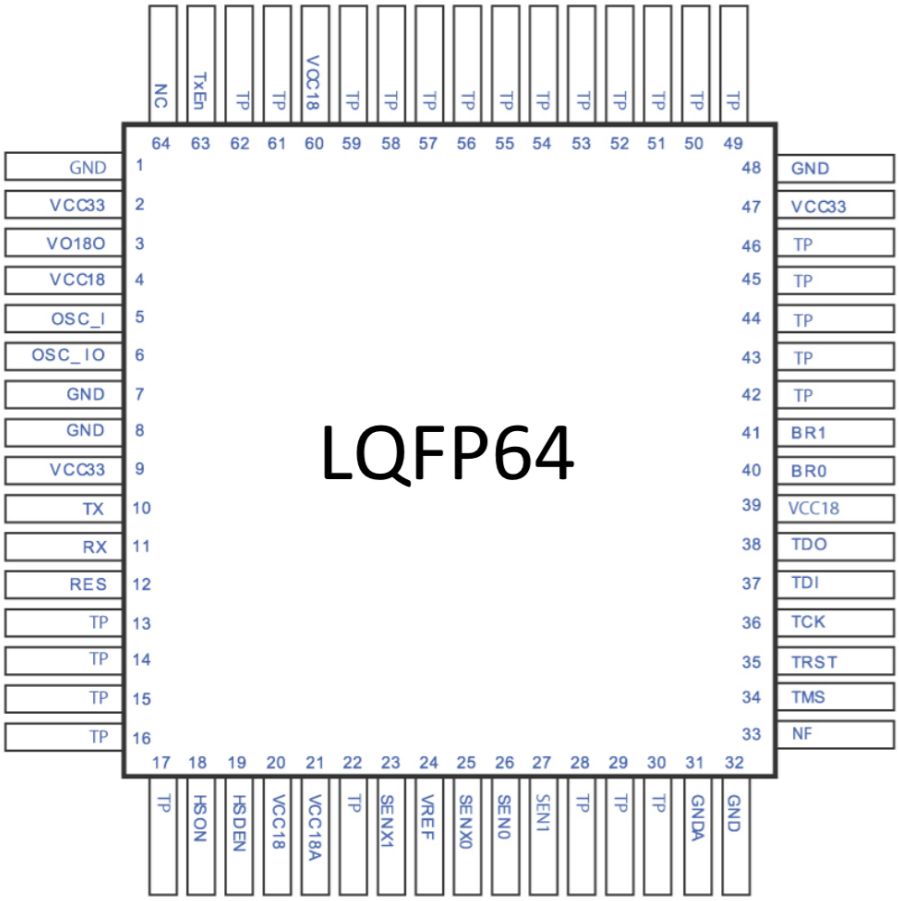


Figure 3.1: Package Top View

Pin Descriptions

Pin No.	Name	Type	Description
1	GND	Power	Digital Ground
2	VCC33	Power	3.3V Digital Power Supply
3	VO18O	Power	On Chip Regulator 1.8V output
4	VCC18	Power	1.8V power supply
5	OSC_IN	Analog Input	Oscillator Input
6	OSC_OUT	Analog Output	Oscillator Output
7	GND	Power	Digital Ground
8	GND	Power	Digital Ground
9	VCC33	Power	3.3V Digital Power Supply
10	TX	Digital Output	UART TX
11	RX	Digital Input	UART RX, Pull high with Schmitt trigger in default state
12	RES	Digital Input	Global Reset, Active high to reset the whole chip. Pull down with Schmitt trigger in default state.
13	TP		Test Pin. No connect.
14	TP		Test Pin. Connect to digital ground.
15	TP		Test Pin. Connect to digital ground.
16	TP		Test Pin. Connect to digital ground.
17	TP		Test Pin. Connect to digital ground.
18	HSON	Digital Output	Headset On output
19	HSDEN	Digital Input	Off head detection enable pin
20	VCC18	Power	1.8V digital power supply
21	VCC18A	Power	1.8V analog power supply
22	TP		Test Pin. Connect to analog ground.
23	SENX1	Analog Input	Sensor Input 1
24	VREF	Analog Input	Sensor Input Reference
25	SENX0	Analog Input	Sensor Input 0

Pin No.	Name	Type	Description
26	SEN0	Analog Input	Sensor Input 0
27	SEN1	Analog Input	Sensor Input 1
28	TP		Test Pin. Connect to analog ground.
29	TP		Test Pin. No connect.
30	TP		Test Pin. No connect.
31	GNDA	Power	Analog ground
32	GND	Power	Digital ground
33	NF	Digital Input	Notch Filter Configuration Pin. Pull it high for 60Hz notch and pull it low for 50Hz notch. Do not leave this pin floating.
34	TP		Test Pin. No connect.
35	TP		Test Pin. Connect to digital ground.
36	TP		Test Pin. No connect.
37	TP		Test Pin. No connect.
38	TP		Test Pin. No connect.
39	VCC18	Power	1.8V Digital Power Supply
40	BR0	Digital Input	UART Baud Rate Select Pin
41	BR1	Digital Input	UART Baud Rate Select Pin
42	TP		Test Pin. No connect.
43	TP		Test Pin. No connect.
44	TP		Test Pin. No connect.
45	TP		Test Pin. No connect.
46	TP		Test Pin. No connect.
47	VCC33	Power	3.3V digital power supply
48	GND	Power	Digital ground
49	TP		Test Pin. No connect.
50	TP		Test Pin. No connect.
51	TP		Test Pin. No connect.
52	TP		Test Pin. No connect.

Pin No.	Name	Type	Description
53	TP		Test Pin. No connect.
54	TP		Test Pin. No connect.
55	TP		Test Pin. No connect.
56	TP		Test Pin. No connect.
57	TP		Test Pin. No connect.
58	TP		Test Pin. No connect.
59	TP		Test Pin. No connect.
60	VCC18	Power	1.8V digital power supply
61	TP		Test Pin. Connect to digital ground.
62	TP		Test Pin. Connect to digital ground.
63	TxEn	Digital Input	UART output enable pin, Active high
64	NC		Not connected.

Internal Pull-up/downs

Pin	Pull-up/down	Impedance
BR1 and BR0	Pull Down	75k
NF	None	Infinite
RXD	Pull Up	75k

Usage Information

Baud Rate Configuration

Use the table below to setup the desired baud rate. Note that the outputs will be also different at each baud rates.

BR1	BR0	Function
GND	GND	9600 Baud with Normal Output Mode
GND	VCC	1200 Baud with Normal Output Mode
VCC	GND	57.6k Baud with Normal + Raw Output Mode
VCC	VCC	N/A

Notch Filter Configuration

The notch filter can be configured using pin 33 (NF or PAD_MAIN). Pull it high for 60Hz notch and pull it low for 50Hz notch.

Important: Do not leave this pin floating. The behavior of the chip can not be guaranteed without the pin configured to power or ground.

Test Pins

Please refer to all the Pin Descriptions on how the TP pins should be setup.

Power line Setups

Recommend 7 capacitors for the power lines. The size and location for the capacitors are listed below:

- 0.1uF for pin 2 & 9
- 0.1uF for pin 47
- 0.1uF for pin 4 & 20
- 0.1uF for pin 21
- 0.1uF for pin 39

- 0.1uF for pin 60
- 1uF for pin 3

Another recommendation is to place a Pi filter in front of the TGAM1 with two 10uF capacitors and one 10uH inductor.

Note: All of these recommendations are demonstrated in the reference design.

Transmit Enable Pin

The UART transmit can be turned off and on by using TxEn. No current consumption testing was done with this pin.

On/Off Head Detection Enable Pin

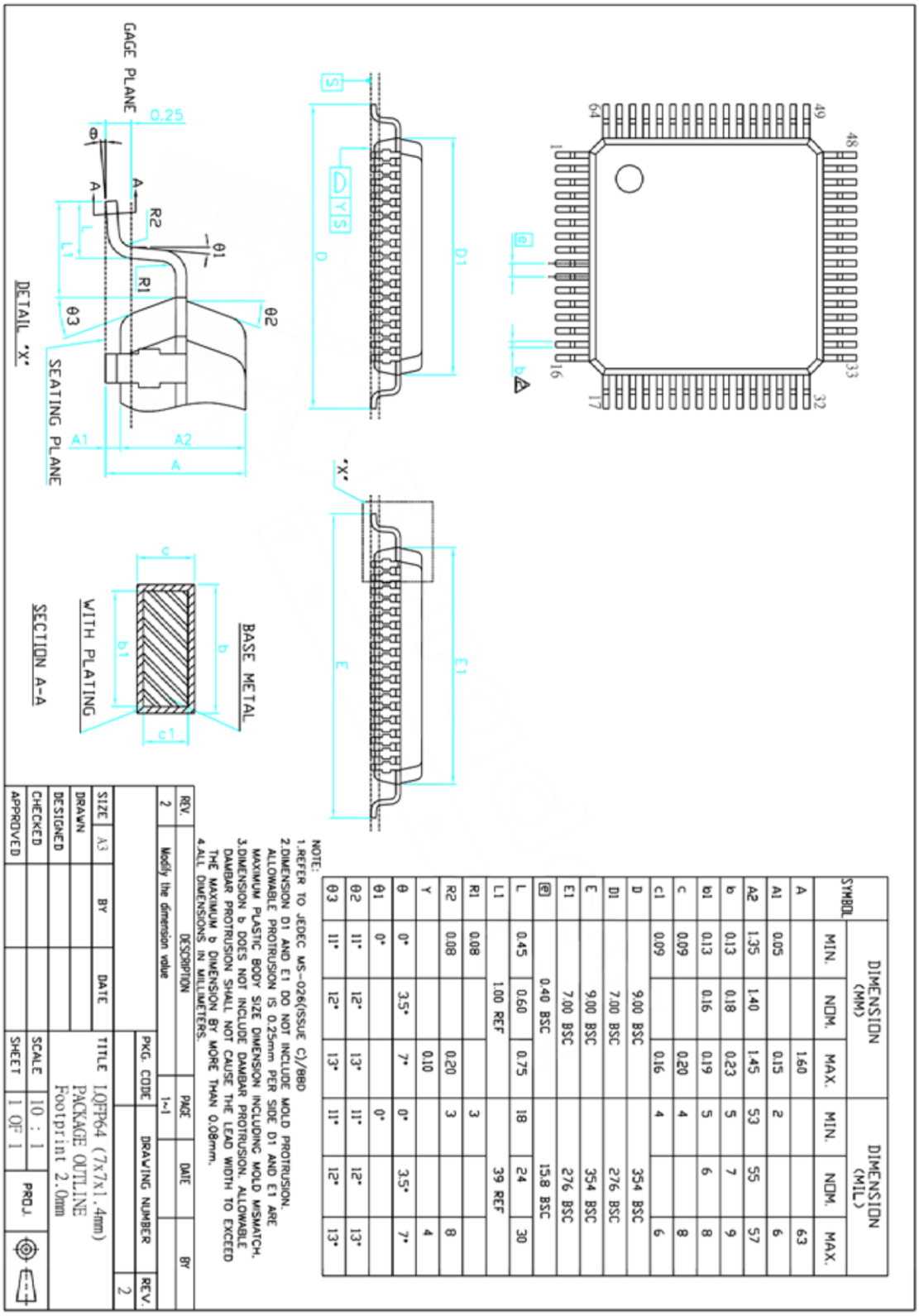
The on/off head detection can be enabled or disabled using the HSDEN. The recommended setup is to keep this pin pulled high. The digital output of the detection can be observed on HSON.

Receiving Data

All the raw EEG data and analyzed data is received via UART

Packaging Information

TGAT is a LQFP64. The detailed package is outlined on the next page.



SYMBOL	DIMENSION (MM) MIN.	NOM.	MAX.	DIMENSION (MIL) MIN.	NOM.	MAX.
A			1.60			63
A1	0.05		0.15	2		6
A2	1.35	1.40	1.45	53	55	57
b	0.13	0.18	0.23	5	7	9
b1	0.13	0.16	0.19	5	6	8
c	0.09		0.20	4		8
c1	0.09		0.16	4		6
D		9.00 BSC			354 BSC	
D1		7.00 BSC			276 BSC	
E		9.00 BSC			354 BSC	
E1		7.00 BSC			276 BSC	
e		0.40 BSC			15.8 BSC	
L	0.45	0.60	0.75	18	24	30
L1		1.00 REF			39 REF	
R1	0.08			3		
R2	0.08		0.20	3		8
Y			0.10			4
θ	0°	3.5°	7°	0°	3.5°	7°
θ1	0°			0°		
θ2	11°	12°	13°	11°	12°	13°
θ3	11°	12°	13°	11°	12°	13°