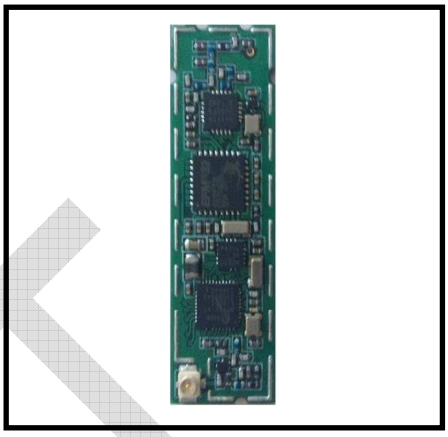
TD1204

HIGH-PERFORMANCE, LOW-CURRENT SIGFOX™ GATEWAY AND GPS RECEIVER

Features



SIGFOX™ certified Gateway and RF transceiver

- Frequency range = ISM 868 MHz
- Receive sensitivity =-126 dBm
- Modulation
  - (G)FSK, 4(G)FSK, GMSK
  - OOK
- Max output power
  - +14 dBm
- Low active radio power consumption
  - 20µA RX (windowed mode)
  - 37 mA TX @ +10 dBm

Multi-GNSS GPS Receiver

- Multi-GNSS support
  - GPS/GLONASS
  - SBAS augmentation services
- Ultra-low power consumption
  - 16 mA Tracking
  - 12 µA Backup
- High Sensitivity
  - 56-channel engine
  - -162 dBm Tracking
  - -148 dBm Cold start

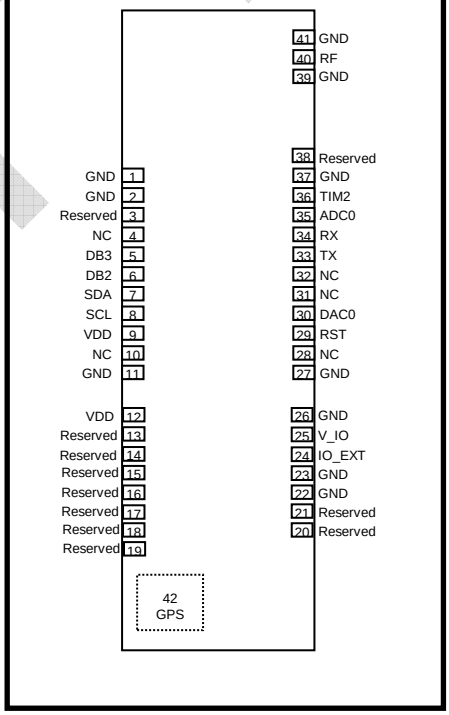
Ultra-low power 3D Accelerometer

- Up to ±16g full scale

Board characteristics

- Power supply = 2.3 to 3.6 V
- 2.5 µA idle state consumption
- LGA41 (41.91×12.7×3.81mm) Land Grid Array package
- Available in several conditioning methods

Pin Assignments



Patents pending

Applications

- SIGFOX™ transceiver (fully certified)
- Geolocation and Tracking
- Universal Timing and Synchronization
- Sensor network
- Health monitors
- Home security and alarm
- Industrial control
- Remote control
- Vehicles and objects tracking
- People and pets geolocation

Description

Telecom Design's TD1204 devices are high performance, low current SIGFOX™ gateways, RF transceiver and GPS receiver. The combination of a powerful radio transceiver, a state-of-the-art ARM Cortex M3 baseband processor and a high-efficiency GPS receiver achieves extremely high performance while maintaining ultra-low active and standby current consumption. The TD1204 device offers an outstanding RF sensitivity of –126 dBm while providing an exceptional output power of up to +14 dBm with unmatched TX efficiency. The TD1204 device versatility provides the gateway function from a local Narrow Band ISM network to the long-distance Ultra Narrow Band SIGFOX™ network at no additional cost. Moreover the fully integrated on-board GPS receiver combines outstanding sensitivity with ultra low power which allows you to achieve excellent accuracy and Time-To-First-Fix performance. Combining the SIGFOX™ network possibilities with accurate geolocation will give you access to a brand new world of embedded applications. The TD1204 also embeds an ultra-low power 3D accelerometer with motion and free fall detection to further extend application range. Eventually the broad range of analog and digital interfaces available in the TD1204 module allows any application to interconnect easily to all peripherals. The LVTTL low-energy UART, the I^2C bus, the multiple timers with pulse count input/PWM output capabilities, the high-resolution/high-speed ADC and DAC, along with the numerous GPIOs can control any kind of external sensors or activators. Featuring an AES encryption engine and a DMA controller, the powerful 32-bit ARM Cortex-M3 baseband processor can implement highly complex and secure protocols in an efficient environmental and very low consumption way.

Functional Block Diagram

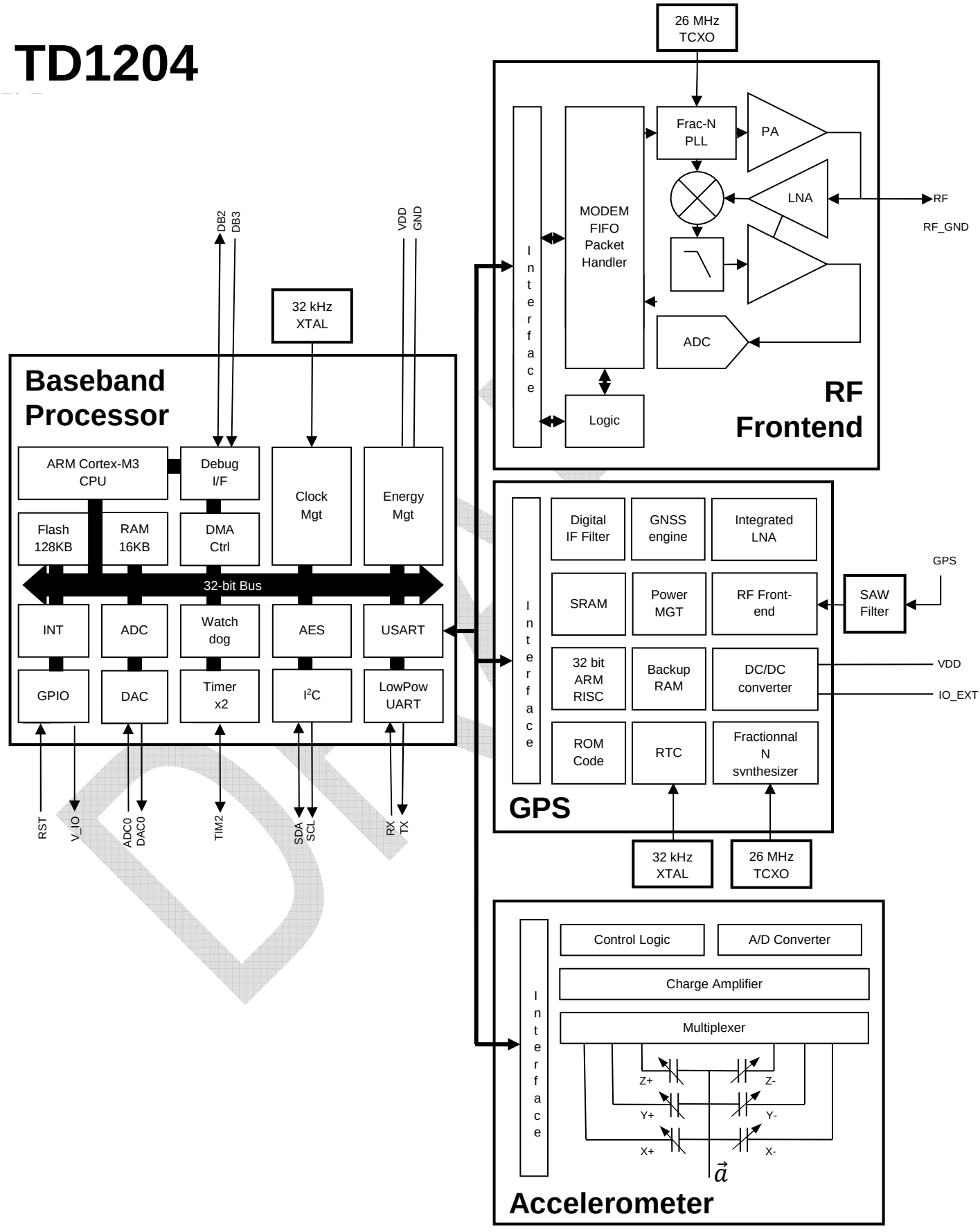


TABLE OF CONTENTS

Section **Page**

1 Electrical Specifications

Table 1. Absolute Maximum Ratings

Parameter	Value	Units
V_{DD} to GND	0 to +3.6	V
V_{IO_EXT} to GND	-0.5 to +3.6	V
Instantaneous $V_{RF\text{-}peak}$ to GND on RF Pin	-0.3 to +8.0	V
Sustained $V_{RF\text{-}peak}$ to GND on RF Pin	-0.3 to +6.5	V
Voltage on Digital Inputs	0 to V_{DD}	V
Voltage on Analog Inputs	0 to V_{DD}	V
RX Input Power	+10	dBm
GPS Input Power	+15	dBm
Operating Ambient Temperature Range T_A	-30 to +75	°C
Storage Temperature Range T_{STG}	–40 to +125	°C
Maximum soldering Temperature	260	°C

Note:
Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at or beyond these ratings in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Power Amplifier may be damaged if switched on without proper load or termination connected. TX matching network design will influence TX $V_{RF\text{-}peak}$ on RF pin. Caution: ESD sensitive device.

Table 2. DC Power Supply Characteristics[1]

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage Range[2]	V_{DD}		2.3	3.3	3.6	V
GPS Digital I/O Supply Voltage Range	V_{IO_EXT}		1.65	3.3	3.6	V
Output Voltage for GPS antenna and I/O monitoring	V_{V_IO}		$0.8V_{DD}$	$0.95\ V_{DD}$	—	V
Output Current for GPS antenna and I/O monitoring	I_{V_IO}		—	—	6	mA
Power Saving Mode[2]	I_{Sleep}	Sleep current using the 32 kHz crystal @ 25°C	1.5	1.8	3.5	µA
Active CPU Mode	I_{Active}	CPU performing active loop @ 14 MHz	2.55	3.0	3.45	mA
Active CPU Mode + RX Mode Current[2]	I_{RX}		—	13	16	mA
Active CPU Mode + TX Mode Current[2]	I_{TX_+14}	+14 dBm output power, 868 MHz, 3.3 V	—	49	—	mA
	I_{TX_+10}	+10 dBm output power, 868 MHz, 3.3 V	—	37	—	mA
GPS Acquisition	I_{ACQ}			22		mA
GPS Tracking	I_{TRA}		—	16	—	mA
GPS Backup	I_{BCKP}		—	12	—	µA
GPS Digital I/O Current[3]	I_{IO_EXT}	Tracking	—	0.5	—	mA

Notes:

1. All specifications guaranteed by production test unless otherwise noted. Production test conditions and max limits are listed in the "Production Test Conditions" section in "1.1. Definition of Test Conditions" on page 5.
2. Guaranteed by qualification. Qualification test conditions are listed in the "Qualification Test Conditions" section in "1.1. Definition of Test Conditions" on page 14.
3. Using a passive antenna. Please keep in mind that I_{IO_EXT} provides current for active external antenna. I_{IO} can provide enough current to power I_{IO_EXT} if you external active antenna does not require more than 5.5mA.

Table 3. Transmitter RF Characteristics[1]

Parameter	Symbol	Conditions	Min	Typ	Max	Units
TX Frequency Range[2]	F_{TX}		868.0	—	869.7	MHz
Modulation Deviation Range[3]	Δf	868.0-869.7 MHz	—	1.5	—	MHz
Modulation Deviation Resolution[3]	F_{RES}	868.0-869.7 MHz	—	28.6	—	Hz
Frequency Error[2]	F_{ERR_25}	868.0-869.7 MHz, 25°C, 3.3 V	—	±2	—	kHz
	F_{ERR_M20}	868.0-869.7 MHz, -20°C, 3.3 V	—	±3	—	kHz
	F_{ERR_55}	868.0-869.7 MHz, 55°C, 3.3 V	—	±3	—	kHz
Average Conducted Power[2]	P_{AVCDP1}	-20°C to 55°C, 868.0 MHz to 868.6 MHz, 3.3 V	—	—	14	dBm
	P_{AVCDP2}	-20°C to 55°C, 868.6 MHz to 868.7 MHz, 3.3 V	—	—	10	dBm
	P_{AVCDP3}	-20°C to 55°C, 868.7 MHz to 869.2 MHz, 3.3 V	—	—	14	dBm
	P_{AVCDP4}	-20°C to 55°C, 869.2 MHz to 869.25 MHz, 3.3 V	—	—	10	dBm
	P_{AVCDP5}	-20°C to 55°C, 869.25 MHz to 869.3 MHz, 3.3 V	—	—	10	dBm
	P_{AVCDP6}	-20°C to 55°C, 869.3 MHz to 869.4 MHz, 3.3 V	—	—	10	dBm
	P_{AVCDP7}	-20°C to 55°C, 869.65 MHz to 869.7 MHz, 3.3 V	—	—	14	dBm
Transient Power[2]	P_{TP}	868.0-869.7 MHz, 25°C, 3.3 V, 4800 bps, deviation 2500 Hz, cable loss 0.2 dB, antenna gain 2 dBi	—	—	3	dB
Adjacent Channel Power[2]	P_{ACP_25}	868.0-869.7 MHz, 25°C, 3.3 V, 4800 bps, deviation 2500 Hz, cable loss 0.2 dB, antenna gain 2 dBi	—	-50	—	dBm
	P_{ACP_M20}	868.0-869.7 MHz, -20°C, 3.3 V, 4800 bps, deviation 2500 Hz, cable loss 0.2 dB, antenna gain 2 dBi	—	-51	—	dBm
	P_{ACP_55}	868.0-869.7 MHz, 55°C, 3.3 V, 4800 bps, deviation 2500 Hz, cable loss 0.2 dB, antenna gain 2 dBi	—	-50	—	dBm
Spurious Emissions[2]	P_{OB_TX1}	Frequencies < 30 MHz, 868.0-869.7 MHz, 25°C, 3.3 V, 4800 bps, deviation 2500 Hz, cable loss 0.2 dB, antenna gain 2 dBi	—	-82	—	dBm
	P_{OB_TX2}	Frequencies < 1 GHz, 868.0-869.7 MHz, 25°C, 3.3 V, 4800 bps, deviation 2500 Hz, cable loss 0.2 dB, antenna gain 2 dBi	—	-58	—	dBm
	P_{OB_TX3}	Frequencies > 1 GHz, 868.0-869.7 MHz, 25°C, 3.3 V, 4800 bps, deviation 2500 Hz, cable loss 0.2 dB, antenna gain 2 dBi	—	-37	—	dBm

Notes:

4. All specifications guaranteed by production test unless otherwise noted. Production test conditions and max limits are listed in the "Production Test Conditions" section of "1.1. Definition of Test Conditions" on page 5.
5. Guaranteed by qualification. Qualification test conditions are listed in the "Qualification Test Conditions" section in "1.1. Definition of Test Conditions" on page 14.
6. Guaranteed by component specification.

Table 4. Receiver RF Characteristics[1]

Parameter	Symbol	Conditions	Min	Typ	Max	Units
RX Frequency Range[2]	F_{RX}		868.0	—	869.7	MHz
Synthesizer Frequency Resolution[3]	F_{RES}	868.0-869.7 MHz	—	28.6	—	Hz
Blocking[2,4]	$2M_{BLOCK}$	Frequency offset ± 2 MHz, 868.0-869.7 MHz, 25°C, 3.3 V	—	-38	—	dB
	$10M_{BLOCK}$	Frequency offset ± 10 MHz, 868.0-869.7 MHz, 25°C, 3.3 V	—	-62	—	dB
Spurious Emissions[2]	P_{OB_RX1}	From 9 kHz to 1 GHz, 868.0-869.7 MHz, 25°C, 3.3 V	—	-84	—	dBm
	P_{OB_RX2}	From 1 GHz to 6 GHz, 868.0-869.7 MHz, 25°C, 3.3 V	—	-70	—	dBm
RX Sensitivity[3]	$P_{RX\_0.5}$	(BER < 0.1%) (500 bps, GFSK, BT = 0.5, Δf = ±250 Hz)	—	-126	—	dBm
	P_{RX_40}	(BER < 0.1%) (40 kbps, GFSK, BT = 0.5, Δf = ±20 kHz)	—	-110	—	dBm
	P_{RX_100}	(BER < 0.1%) (100 kbps, GFSK, BT = 0.5, Δf = ±50 kHz)	—	-106	—	dBm
	P_{RX_125}	(BER < 0.1%) (125 kbps, GFSK, BT = 0.5, Δf = ±62.5 kHz)	—	-105	—	dBm
	P_{RX_500}	(BER < 0.1%) (500 kbps, GFSK, BT = 0.5, Δf = ±250 kHz)	—	-97	—	dBm
	$P_{RX\_9.6}$	(BER < 0.1%) (9.6 kbps, GFSK, BT = 0.5, Δf = ±2.4 kHz)	—	-110	—	dBm
	P_{RX_1M}	(BER < 0.1%) (1 Mbps, GFSK, BT = 0.5, Δf = ±1.25 kHz)	—	-88	—	dBm
	P_{RX_OOK}	(BER < 0.1%, 4.8 kbps, 350 kHz BW, OOK, PN15 data)	—	-109	—	dBm
		(BER < 0.1%, 40 kbps, 350 kHz BW, OOK, PN15 data)	—	-104	—	dB
		(BER < 0.1%, 120 kbps, 350 kHz BW, OOK, PN15 data)	—	-99	—	dBm
RSSI Resolution[3]	RES_{RSSI}		—	±0.5	—	dB

Notes:

1. All specifications guaranteed by production test unless otherwise noted. Production test conditions and max limits are listed in the "Production Test Conditions" section of "1.1. Definition of Test Conditions" on page 5.
2. Guaranteed by qualification. Qualification test conditions are listed in the "Qualification Test Conditions" section in "1.1. Definition of Test Conditions" on page 14.
3. Guaranteed by component specification.
4. The typical blocking values were obtained while seeking for EN 300-220 Category 2 compliance only. The typical value specified in the component datasheet are -75 dB and -84 dB at 1 and 8 MHz respectively, with desired reference signal 3 dB above sensitivity, BER = 0.1%, interferer is CW, and desired is modulated with 2.4 kbps, ΔF = 1.2 kHz GFSK with BT = 0.5, RX channel BW = 4.8 kHz. The RF component manufacturer provides a reference design featuring a SAW filter which is EN 300-220 Category 1 compliant. Please contact Telecom Design for more information on EN 300-220 Category 1 compliance.

Table 5. All Digital I/O DC & AC Characteristics[1]

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Low Voltage[2]	V_{IOIL}		—	—	$0.3V_{DD}$	V
Input High Voltage[2]	V_{IOIH}		$0.7V_{DD}$	—	—	V
Output High Voltage[2]	V_{IOOH}	Sourcing 6 mA, VDD = 3.0V, Standard Drive Strength	$0.95V_{DD}$	—	—	V
		Sourcing 20 mA, VDD = 3.0V, High Drive Strength	$0.9V_{DD}$	—	—	V
Output Low Voltage[2]	V_{IOOL}	Sinking 6 mA, VDD=3.0V, Standard Drive Strength	—	—	$0.05V_{DD}$	V
		Sinking 20 mA, VDD=3.0V, High Drive Strength	—	—	$0.1V_{DD}$	V
Input Leakage Current[2]	I_{IOLEAK}	High Impedance I/O connected to GND or V_{DD}	—	—	±25	nA
I/O Pin Pull-Up Resistor[2]	R_{PU}		—	40	—	kΩ
I/O Pin Pull-Down Resistor[2]	R_{PD}		—	40	—	kΩ
Internal ESD Series Resistor[2]	R_{IOESD}		—	200	—	Ω
Pulse Width of Pulses to be Removed by the Glitch Suppression Filter[2]	$t_{IOGLITCH}$		10	—	50	ns
Output Fall Time[2]	t_{IOOF}	0.5 mA Drive Strength and Load Capacitance C_L = 12.5 to 25 pF	$20+0.1C_L$	—	250	ns
		2 mA Drive Strength and Load Capacitance C_L = 350 to 600 pF	$20+0.1C_L$	—	250	ns
I/O Pin Hysteresis (V_{IOTHR+} - V_{IOTHR-})[2]	V_{IOHYST}	V_{DD} = 2.3 to 3.6 V	$0.1V_{DD}$	—	—	V

Notes:

1. All specifications guaranteed by production test unless otherwise noted. Production test conditions and max limits are listed in the “Production Test Conditions” section of “1.1. Definition of Test Conditions” on page 14.
2. Guaranteed by component specification.

Table 6. ADC DC & AC Characteristics[1]

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage Range[2]	V_{ADCIN}	Single Ended	0	—	V_{REF}	V
		Differential	$-V_{REF}/2$	—	$V_{REF}/2$	V
Common Mode Input Range[2]	$V_{ADCCMIN}$		0	—	V_{DD}	V
Input Current[2]	I_{ADCIN}	2 pF Sampling Capacitors	—	<100	—	nA
Analog Input Common Mode Rejection Ratio[2]	$CMRR_{ADC}$		—	65	—	dB
Average Active Current[2]	I_{ADC}	10 ksps/s 12 bit, Internal 1.25 V Reference, Warmup Mode = 0	—	67	—	µA
		10 ksps/s 12 bit, Internal 1.25 V Reference, Warmup Mode = 1	—	63	—	µA
		10 ksps/s 12 bit, Internal 1.25 V Reference, Warmup Mode = 2	—	64	—	µA
Current Consumption of Internal Voltage Reference[2]	I_{ADCREF}		—	65	—	µA
Input Capacitance[2]	C_{ADCIN}		—	2	—	pF
Input ON Resistance[2]	R_{ADCIN}		1	—	—	MΩ
Input RC Filter Resistance[2]	$R_{ADCFILT}$		—	10	—	kΩ
Input RC Filter/Decoupling Capacitance[2]	$C_{ADCFILT}$		—	250	—	fF
ADC Clock Frequency[2]	f_{ADCCLK}		—	—	13	MHz
Conversion Time[2]	$t_{ADCCONV}$	6 bit	7	—	—	ADC CLK Cycles
		10 bit	11	—	—	ADC CLK Cycles
		12 bit	13	—	—	ADC CLK Cycles
Acquisition Time[2]	t_{ADCACQ}	Programmable	1	—	256	ADC CLK Cycles
Required Acquisition Time for $V_{DD}/3$ Reference[2]	$t_{ADCACQVDD3}$		2	—	—	µs

Notes:

1. All specifications guaranteed by production test unless otherwise noted. Production test conditions and max limits are listed in the “Production Test Conditions” section of “1.1. Definition of Test Conditions” on page 14.
2. Guaranteed by component specification.

Table 7. ADC DC & AC Characteristics[1] (continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Startup Time of Reference Generator and ADC Core in NORMAL Mode[2]	$t_{ADCSTART}$		—	5	—	µs
Startup Time of Reference Generator and ADC Core in KEEPADCWARM Mode[2]			—	1	—	µs
Offset Voltage[2]	$V_{ADCOFFSET}$	After calibration, single ended	—	0.3	—	mV
		After calibration, differential	—	0.3	—	mV
Thermometer Output Gradient[2]	$TGRAD_{ADCTH}$		—	-1.92	—	mV/°C
			—	-6.3	—	ADC Codes / °C
Differential Non-Linearity (DNL) [2]	DNL_{ADC}		—	±0.7	—	LSB
Integral Non-Linearity (INL), End Point Method[2]	INL_{ADC}		—	±1.2	—	LSB
No Missing Codes[2]	MC_{ADC}		11.999[3]	12	—	bits
Gain Error Drift[2]	$GAIN_{ED}$	1.25V Reference	—	0.01[4]	0.033[5]	%/°C
		2.25V Reference	—	0.01[4]	0.03[5]	%/°C
		1.25V Reference	—	0.2[4]	0.07[5]	LSB/°C
		2.25V Reference	—	0.2[4]	0.62[5]	LSB/°C

Notes:

1. All specifications guaranteed by production test unless otherwise noted. Production test conditions and max limits are listed in the “Production Test Conditions” section of “1.1. Definition of Test Conditions” on page 14.
2. Guaranteed by component specification.
3. On the average every ADC will have one missing code, most likely to appear around 2048 +/- n*512 where n can be a value in the set {-3, -2, -1, 1, 2, 3}. There will be no missing code around 2048, and in spite of the missing code the ADC will be monotonic at all times so that a response to a slowly increasing input will always be a slowly increasing output. Around the one code that is missing, the neighbor codes will look wider in the DNL plot. The spectra will show spurs on the level of -78dBc for a full scale input for chips that have the missing code issue.
4. Typical numbers given by abs(Mean) / (85 - 25).
5. Max number given by (abs(Mean) + 3x stddev) / (85 - 25).

Table 8. DAC DC & AC Characteristics[1]

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Output Voltage Range[2]	V_{DACOUT}	V_{DD} voltage reference, Single Ended	0	—	V_{DD}	V
Output Common Mode Voltage Range[2]	V_{DACCM}		0	—	V_{DD}	V
Active Current Including References for 2 Channels [2]	I_{DAC}	500 ksps/s 12 bit	—	400	—	µA
		500 ksps/s 12 bit	—	200	—	µA
		100 ksps/s 12 bit NORMAL	—	38	—	µA
Sample Rate[2]	SR_{DAC}		—	—	500	ksps
DAC Clock Frequency[2]	f_{DAC}	Continuous Mode	—	—	1000	kHz
		Sample/Hold Mode			250	kHz
		Sample/Off Mode			250	kHz
Clock Cycles per Conversion [2]	$CYC_{DACCONV}$		—	2	—	DAC CLK Cycles
Conversion Time[2]	$t_{DACCONV}$		2	—	—	µs
Settling Time[2]	$t_{DACSETTLE}$		—	5	—	µs
Signal to Noise Ratio (SNR)[2]	SNR_{DAC}	500 ksps, 12 bit, single ended, internal 1.25V reference	—	58	—	dB
		500 ksps, 12 bit, single ended, internal 2.5V reference	—	59	—	dB
Signal to Noise-Pulse Distortion Ratio (SNDR)[2]	$SNDR_{DAC}$	500 ksps, 12 bit, single ended, internal 1.25V reference	—	57	—	dB
		500 ksps, 12 bit, single ended, internal 2.5V reference	—	54	—	dB
Spurious-Free Dynamic Range(SFDR)[2]	$SFDR_{DAC}$	500 ksps, 12 bit, single ended, internal 1.25V reference	—	62	—	dB
		500 ksps, 12 bit, single ended, internal 2.5V reference	—	56	—	dB
Offset Voltage[2]	$V_{DACOFFSET}$	After calibration, single ended	—	2	—	mV
Differential Non-Linearity[2]	DNL_{DAC}		—	±1	—	LSB
Integral Non-Linearity[2]	INL_{DAC}		—	±5	—	LSB
No Missing Codes[2]	MC_{DAC}		—	12	—	bits

Notes:

1. All specifications guaranteed by production test unless otherwise noted. Production test conditions and max limits are listed in the "Production Test Conditions" section of "1.1. Definition of Test Conditions" on page 14.
2. Guaranteed by component specification.

Table 9. Accelerometer mechanical characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Measurement range	FS		±2	—	±16	g
Sensitivity	So		1	—	12	mg/digit
Sensitivity change vs temperature	TCSo	FS=±2g	—	0.01	—	%/°C
Typical zero-g level offset accuracy	TyOff	FS=±2g		±40		mg
Zero-g level change vs temperature	TCOff	Max delta from 25°C		±0.5		mg/°C
Acceleration noise density	An	FS=±2g		220		µg/sqrt(Hz)
Notes:						

1.1 Indicative energy requirements

The following tables show indicative energy requirements for key-point functionalities of a TD1204 module based on Telecom Design's software library. All indicated values are for V_{DD} = 3.0V.

Table 10. Indicative energy requirements for SIGFOX™ and LAN RF Application

Function	Conditions	Min	Typ	Max	Units
Idle state	Per hour	—	0.0025	—	mAh
LAN RF Reception	Windowed mode, per hour	—	0.02	—	mAh
LAN RF TX+ACK[1]		—	0.01	—	mAh
Sigfox™ Transmission	Transmission of 12 payload bytes	—	0.083	—	mAh

Notes:
1. Includes transmission of 17 payload bytes and reception of an ACK.

Table 11. Indicative energy requirements for GPS application

Function	Conditions	Min	Typ	Max	Units
3D movement detection	Accelerometer 1Hz, per hour	—	0.004	—	mAh
GPS position acquisition[1]	Cold start fix obtained in 30 seconds	—	0.225	—	mAh
GPS position acquisition and SIGFOX™ transmission	Accelerometer 1Hz, Cold start fix obtained in 30 seconds	—	0.308	—	mAh

Notes:
1. With a 5mA active external GPS antenna.
2. Transmission of longitude, latitude and altitude information.

Table 12. Indicative battery life for typical user case

The following table shows indicative battery life for some typical user-cases based on the TD1204 module.

User case	Battery capacity (mAh)[1]	Lifetime
1 SIGFOX™ transmission per day[2]	100	1.8 years
	250	4.4 years
	500	8 years
1 GPS position acquisition and SIGFOX™ transmission per day[3]	100	270 days
	250	1.8 years
	500	3.4 years
Movement detection plus 1 GPS position acquisition and SIGFOX™ transmission per day[3]	100	246 days
	250	1.6 years
	500	3.1 years
GPS position acquisition every 10 minutes and position transmission when long-distance movements detected[4]	500	90 days
	1000	180 days
	2500	1.2 years

Notes:
1. Assuming a 3V battery with 0.16% discharge per month.
2. With a 12-byte payload and +14dBm output power.
3. Assuming a 30 seconds cold start fix and a 5mA active external GPS antenna. Transmission of longitude, latitude and altitude information.
4. Assuming a 5 second warm start fix, a 5mA active external GPS antenna and 12 long-distance movements per day. Transmission of longitude, latitude and altitude information.

1.2 Definition of Test Conditions

1.2.1 Production Test Conditions:

- T_A = + 25°C
- V_{DD} = +3.3 VDC
- Production test schematics (unless noted otherwise)
- All RF input and output levels referred to the pins of the TD1204 module

1.2.2 Qualification Test Conditions:

- T_A = -30 to +75°C (Typical T_A = 25°C)
- V_{DD} = +2.3 to 3.6 VDC (Typical V_{DD} = 3.3 VDC)
- Using TX/RX Split Antenna reference design or production test schematic
- All RF input and output levels referred to the pins of the TD1204 module

2 Functional Description

The TD1204 devices are high-performance, low-current, wireless SIGFOX™ gateways, RF transceiver, GPS receiver and accelerometer. The wide operating voltage range of 2.3–3.6 V and low current consumption make the TD1204 an ideal solution for battery powered applications.

The TD1204 operates as a time division duplexing (TDD) transceiver where the device alternately transmits and receives data packets. The device uses a single-conversion mixer to downconvert the 2-level FSK/GFSK or OOK/ASK modulated receive signal to a low IF frequency. Following a programmable gain amplifier (PGA) the signal is converted to the digital domain by a high performance ΔΣ ADC allowing filtering, demodulation, slicing, and packet handling to be performed in the built-in DSP increasing the receiver's performance and flexibility versus analog based architectures. The demodulated signal is output to the baseband CPU by reading the 64-byte RX FIFO.

A single high precision local oscillator (LO) is used for both transmit and receive modes since the transmitter and receiver do not operate at the same time. The LO is generated by an integrated VCO and ΔΣ Fractional-N PLL synthesizer. The synthesizer is designed to support configurable data rates from 0.123 kbps to 1 Mbps. The TD1204 operates in the frequency bands of 868.0–869.7 MHz with a maximum frequency accuracy step size of 28.6 Hz. The transmit FSK data is modulated directly into the ΔΣ data stream and can be shaped by a Gaussian low-pass filter to reduce unwanted spectral content.

The power amplifier (PA) supports output power up to +14 dBm with very high efficiency, consuming only 37 mA at +10 dBm. The integrated power amplifier can also be used to compensate for the reduced performance of a lower cost, lower performance antenna or antenna with size constraints due to a small form-factor. The PA is single-ended to allow for easy antenna matching and low BOM cost. The PA incorporates automatic ramp-up and ramp-down control to reduce unwanted spectral spreading. A highly configurable packet handler allows for autonomous encoding/decoding of nearly any packet structure.

As both the local Narrow Band ISM network and the long-distance Ultra Narrow Band SIGFOX™ network can be addressed seamlessly, the TD1204 device provides a natural gateway function at no additional cost. Thus, the same TD1204 module can be used both for local RF communication with peer modules, and also connect to the wide-area SIGFOX™ RF network.

The broad range of analog and digital interfaces available in the TD1204 module allows any application to interconnect easily to the SIGFOX™ network. The LVTTL low-energy UART, the I^2C bus, the multiple timers with pulse count input/PWM output capabilities, the high-resolution/high-speed ADC and DAC, along with the numerous GPIOs can control any kind of external sensors or activators. Featuring an AES encryption engine and a DMA controller, the powerful 32-bit ARM Cortex-M3 baseband processor can implement highly complex and secure protocols in an efficient environmental and very low consumption way. This unique combination of a powerful 32-bit ARM Cortex-M3 CPU including innovative low energy techniques, short wake-up time from energy saving modes, and a wide selection of intelligent peripherals allows any application to connect to the SIGFOX™ network.

The application shown in Figure 1 shows the minimum interconnection required to operate the TD1204 module.

Basically, only the 8 GND, 2 RF_GND, V_{DD}, V_IO, IO_EXT, TX, RX and RF antenna pin connections are necessary. The RST (reset) pin connection is not mandatory and this pin can be left floating if not used.

A 10 µF/6.3V decoupling capacitor must be added as close as possible to the V_{DD} on pin 9.

A 4.7 µF/6.3V decoupling capacitor must be added as close as possible to the V_{DD} on pin 12.

A 1.0 µF/6.3V decoupling capacitor must be added as close as possible to IO_EXT.

The TX/RX pins are LVTTL-compatible and feature internal pull-up resistors.

A 50 Ω matched RF antenna must be connected to the RF pin.

An external active GPS antenna must be connected to the U.FL connector (reference U.FL-R-SMT-1 from Hirose) on top of the PCB. The antenna will be powered by the power supply connected to IO_EXT through the U.FL connector. Supported U.FL connector sizes are 1.9mm or 2.4mm. A typical application should use an external active antenna requiring less than 5.5mA to be powered. Otherwise please contact Telecom Design for a reference design.

The connection of a super-blue LED with series current-limiting resistor of 220 Ω on pin TIM2 is recommended in order to display the bootloader status at boot time.

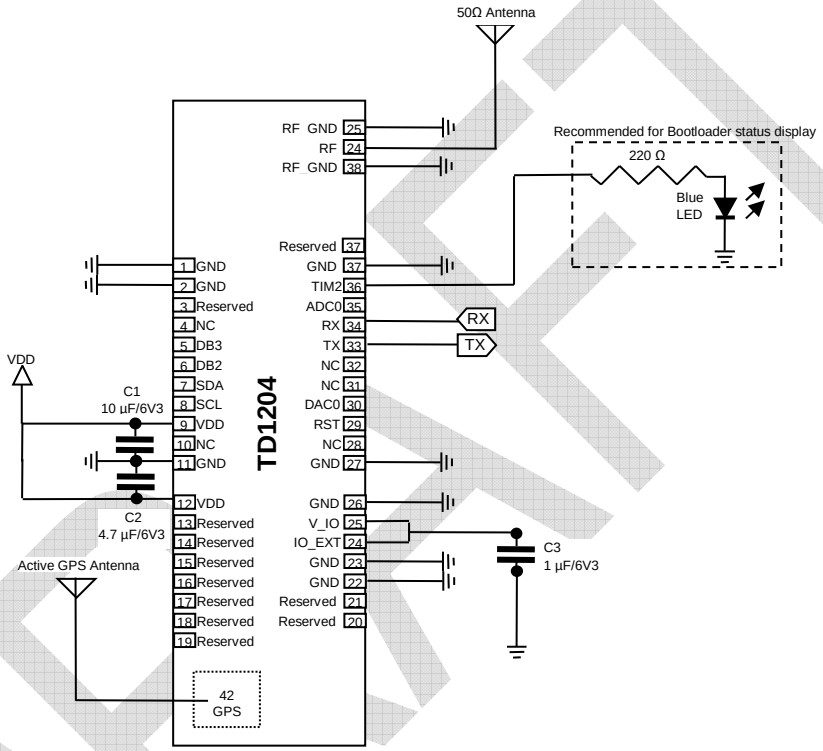


Figure 1. Typical Application

3 Module Interface

3.1 Low-Power UART (Universal Asynchronous Receiver/Transmitter)

The TD1204 communicates with the host MCU over a standard asynchronous serial interface consisting of only 2 pins: TX and RX. The TX pin is used to send data from the TD1204 module to the host MCU, and the RX pin is used to receive data into the TD1204 module coming from the host MCU.

This interface allows two-way UART communication to be performed in low energy modes, using only a few µA during active communication and only 150 nA when waiting for incoming data.

This serial interface is designed to operate using the following serial protocol parameters:

- LVTTL electrical level
- 9600 bps
- 8 data bits
- 1 stop bit
- No parity
- No hardware/software flow control

This interface operates using LVTTL signal levels to satisfy the common interface to a low power host MCU. If an EIA RS232-compliant interface voltage level is required, an RS232 level translator circuit must be used. It is also possible to use a common USB/UART interface chip to connect to an USB bus.

Over this serial interface, the TD1204 device provides a standard Hayes "AT" command set used to control the module using ASCII readable commands and get answers, as well as to send or receive data.

The list of available commands with their corresponding arguments and return values, a description of their operation and some examples are detailed into the "*TD1204 Reference Manual*".

3.2 I²C bus

As a convenience, the TD1204 module is equipped with a popular I²C serial bus controller that enables communication with a number of external devices using only two I/O pins: SCL and SDA. The SCL pin is used to interface with the I²C clock signal, and the SDA pin to the I²C data signal, respectively. When not used for I2C bus, these 2 pins can be configured to perform other functions using "AT" configuration commands, please refer to the "*TD1204 Reference Manual*" for details.

The TD1204 module is capable of acting as both a master and a slave, and supports multi-master buses. Both standard-mode (Sm), fast-mode (Fm) and fast-mode plus (Fm+) speeds are supported, allowing transmission rates all the way from 10 kbit/s up to 1 Mbit/s. Slave arbitration and timeouts are also provided to allow implementation of an SMBus compliant system. Both 7-bit and 10-bit addresses are supported, along with extensive error handling capabilities (clock low/high timeouts, arbitration lost, bus error detection).

The operation of this interface is controlled by the mean of Hayes "AT" commands sent over the UART interface. To obtain a list of the available commands with their corresponding arguments and return values, a description of their operation and some examples, please refer to the "*TD1204 Reference Manual*".

3.3 Timer/Counter

The TD1204 provides an interface to an integrated timer/counter using the TIM2 pin. This pin can be configured as either a capture input or a compare/PWM output to the 16-bit internal timer/counter. When not used for timer/counter operation, this pin can be configured to perform other functions using "AT" configuration commands, please refer to the "*TD1204 Reference Manual*" for details.

The timer consists in a counter that can be configured to up-count, down-count, up/down-count (continuous or one-shot).

The timer also contains 2 output channels, that can be configured as either an output compare or single/double slope PWM (Pulse-Width Modulation) outputs routed to the TIM2 pin.

The operation of this interface is controlled by the mean of Hayes “AT” commands sent over the UART interface. To obtain a list of the available commands with their corresponding arguments and return values, a description of their operation and some examples, please refer to the “*TD1204 Reference Manual*”.

3.4 ADC (Analog to Digital Converter)

The TD1204 provides an interface to an integrated low-power SAR (Successive Approximation Register) ADC, capable of a resolution of up to 12 bits at up to 1 Msps or 6 bits at up to 1.86 Msps. The ADC0 pin provides the external interface to the ADC. When not used for ADC operation, this pin can be configured to perform other functions using “AT” configuration commands, please refer to the “*TD1204 Reference Manual*” for details.

Along with the ADC0 analog input channel, the ADC also provides an internal temperature, VDD, and GND input channel that may be used to get a digital representation of analog temperature or voltage values. It is also possible to loopback the analog output of the integrated DAC (see section 3.5, “DAC (Digital to Analog Converter)”).

The internal ADC provides an optional input filter consisting of an internal low-pass RC filter or simple internal decoupling capacitor. The resistance and capacitance values are given in the electrical characteristics for the device, named $R_{ADCFILT}$ and $C_{ADCFILT}$ respectively.

The reference voltage used by the ADC can be selected from several sources, including a 1.25 V internal bandgap, a 2.5 V internal bandgap, V_{DD}, a 5 V internal differential bandgap or unbuffered $2V_{DD}$.

Additionally, to achieve higher accuracy, hardware oversampling can be enabled. With oversampling, each selected input is sampled a number of times, and the results are filtered by a first order accumulate and dump filter to form the end result. Using 16x oversampling minimum, it is thus possible to achieve result resolution of upt to 16 bits.

The operation of this interface is controlled by the mean of Hayes “AT” commands sent over the UART interface. To obtain a list of the available commands with their corresponding arguments and return values, a description of their operation and some examples, please refer to the “TD1204 Reference Manual”.

3.5 DAC (Digital to Analog Converter)

The TD1204 provides an interface to an integrated DAC that can convert a digital value to a fully rail-to-rail analog output voltage with 12-bit resolution at up to 500 ksps. The DAC may be used for a number of different applications such as sensor interfaces or sound output. The analog DAC output is routed to the DAC0 pin. When not used for ADC operation, this pin can be configured to perform other functions using “AT” configuration commands, please refer to the “TD1204 Reference Manual” for details.

The reference voltage used by the DAC can be selected from several sources, including a 1.25 V internal bandgap, a 2.5 V internal bandgap, or V_{DD}.

The internal DAC provides support for offset and gain calibration, and contains an automatic sine generation mode as well as a loopback output to the ADC (see section 3.4, “ADC (Analog to Digital Converter)”).

3.6 GPIO (General Purpose Input/Output)

Apart from the TX and RX UART pins, and the RF pins, all signal pins are available as general-purpose inputs/outputs. This includes the ADC0, TIM2, DAC0, SCL, SDA, DB2, DB3 pins when not used for their main function. This configuration can be performed using “AT” commands, please refer to the “TD1204 Reference Manual” for details.

All the ADC0, TIM2, DAC0, SCL, SDA, DB2, DB3 pins can be configured individually as tristate (default reset state), push-pull, open-drain, with/without pull-up or pull-down resistor, and with a programmable drive strength (0.5 mA/2 mA/6 mA/20 mA).

When configured as inputs, these pins feature an optional glitch suppression filter and full (rising, falling or both edges) interrupt with wake-up from low-power mode capabilities. Of course, the pin configuration is retained even when using these low-power modes.

The operation of the GPIOs is controlled by the mean of Hayes "AT" commands sent over the UART interface. To obtain a list of the available commands with their corresponding arguments and return values, a description of their operation and some examples, please refer to the "TD1204 Reference Manual".

3.7 RST (Reset)

The TD1204 module features an active-low RST pin. This pin is held high by an internal pull-up resistor, so when not used, this pin can be left floating.

3.8 Debug

The TD1204 module devices include hardware debug support through a 2-pin serial-wire debug interface. The 2 pins DB2 and DB3 are used for this purpose. The DB2 pin is the ARM Cortex-M3's SWDIO Serial Wire data Input/Output. This pin is enabled after a reset and has a built in pull-up. The DB3 pin is the ARM Cortex-M3's SWCLK Serial Wire Clock input. This pin is enabled after reset and has a built-in pull down. When not used for debug operation, these 2 pins can be configured to perform other functions using "AT" configuration commands, please refer to the "TD1204 Reference Manual" for details.

Although the ARM Cortex-M3 supports advanced debugging features, the TD1204 devices only use two port pins for debugging or programming. The systems internal and external state can be examined with debug extensions supporting instruction or data access break- and watch points.

For more information on how to enable the debug pin outputs/inputs the reader is referred to Section 28.3.4.1 (p. 457), the ARM Cortex-M3 Technical Reference Manual and the ARM CoreSight™ Technical Reference Manual.

3.9 RF Antenna

The TD1204 support a single-ended RF pin with 50 Ω characteristic impedance for connecting a matched-impedance external antenna. This pin is physically surrounded by 2 RF GND pins for better noise immunity.

3.10 GPS Antenna

The TD1204 support a 1.9mm or 2.4mm U.FL RF connector on top of PCB for connecting an external active antenna. Power supply for active antenna is provided through IO_EXT. If your external active antenna does not require more than 5.5mA you can use V_IO to power-up IO_EXT. Otherwise please use an external regulator to provide current supply for IO_EXT and connect V_IO to the regulator's Chip Enable.

3.11 VDD & GND

The TD1204 provides 8 GND pins and 2 RF_GND pins: all of them must be connected to a good ground plane.

A 10 µF/6.3 V decoupling capacitor should be placed as closed as possible to the VDD on pin 9.

A 4.7 µF/6.3 V decoupling capacitor should be placed as closed as possible to the VDD on pin 12.

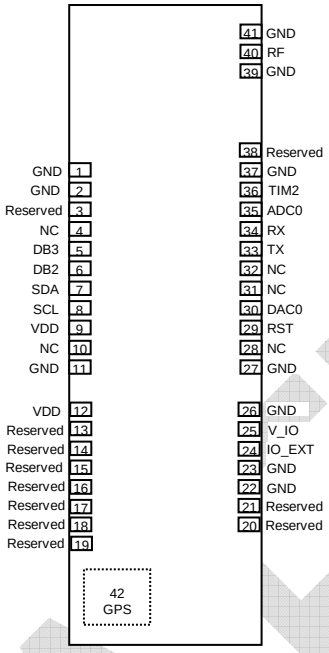
4 Bootloader

The TD1204 module contains an integrated bootloader which allows reflashing the module firmware either over the RX/TX UART connection, or over the air using the built-in RF transceiver.

The bootloader is automatically activated upon module reset. Once activated, the bootloader will monitor the UART/RF activity for a 200 ms period, and detect an incoming update condition.

If the update condition is met, the TD1204 will automatically proceed to flash the new firmware with safe retry mechanisms, or falls back to normal operation.

5 Pin Descriptions



Pin	Pin Name	I/O	Description
1	GND	GND	**Connect to PCB ground**
2	GND	GND	**Connect to PCB ground**
3	Reserved	I/O	**Reserved pin – Do not connect**
4	NC	NC	**Not connected**
5	DB3	I	**SWDCLK (SWD Clock) Signal** This signal provides the SWD clock signal to the integrated TD1204 ARM® CPU. This pin may be configured to perform various functions.
6	DB2	I/O	**SWDIO (SWD Data I/O) Signal** This signal provides the SWD programming/debugging signal interface to the integrated TD1204 ARM® CPU. This pin may be configured to perform various functions.
7	SDA	I/O	**General Purpose Low-Power Digital I/O** This pin may be configured to perform various functions, including the I^2C DATA (SDA) function.
8	SCL	I/O	**General Purpose Low-Power Digital I/O** This pin may be configured to perform various functions, including the I^2C clock (SCL) function.
9	VDD	VDD	**+2.3 to +3.6 V Supply Voltage Input** The recommended VDD supply voltage is +3.3V. Connect a 10 µF capacitor as close as possible to this input.
10	NC	NC	**Not connected**
11	GND	GND	**Connect to PCB ground**
12	VDD	VDD	**+1.65 to +3.6 V GPS Supply Voltage Input** The recommended VDD supply voltage is +3.3V. Connect a 4.7 µF capacitor as close as possible to this input.
13	Reserved	I/O	**Reserved pin – Do not connect**

14	Reserved	I/O	**Reserved pin – Do not connect**
15	Reserved	I/O	**Reserved pin – Do not connect**
16	Reserved	I/O	**Reserved pin – Do not connect**
17	Reserved	I/O	**Reserved pin – Do not connect**
18	Reserved	I/O	**Reserved pin – Do not connect**
19	Reserved	I/O	**Reserved pin – Do not connect**
20	Reserved	I/O	**Reserved pin – Do not connect**
21	Reserved	I/O	**Reserved pin – Do not connect**
22	GND	GND	**Connect to PCB ground**
23	GND	GND	**Connect to PCB ground**
24	IO_EXT		**+1.65 to +3.6 V GPS Digital I/O and Antenna Supply Voltage Input** Connect a 1.0 µF capacitor as close as possible to this input. Drive with V_IO if your external active antenna requires less than 5.5mA. Otherwise drive with appropriate hardware.
25	V_IO	O	**GPS Digital I/O Supply Voltage Output**
26	GND	GND	**Connect to PCB ground**
27	GND	GND	**Connect to PCB ground**
28	NC	NC	**Reserved pin – Do not connect**
29	RST	I	**Active Low RESET input signal** This signal resets the TD1204 module to its initial state. If not used, this signal can be left floating, as it is internally pulled up by an integrated resistor.
30	DAC0	I/O	**General Purpose Low-Power Digital I/O** This pin may be configured to perform various functions, including the DAC analog output #0 function.
31	NC	NC	**Reserved pin – Do not connect**
32	NC	NC	**Reserved pin – Do not connect**
33	TX	O	**Low-Power UART Data Transmit Signal** This signal provides the UART data going from the TD1204 module out to the host application processor. This signal is internally pulled up by an integrated resistor.
34	RX	I	**Low-Power UART Data Receive Signal** This signal provides the UART data coming from the host application processor going to the TD1204 module. This signal is internally pulled up by an integrated resistor.
35	ADC0	I/O	**General Purpose Low-Power Digital I/O** This pin may be configured to perform various functions, including the ADC input #6 function.
36	TIM2	I/O	**General Purpose Low-Power Digital I/O** This pin may be configured to perform various functions, including the timer input capture / output compare #2 function.
37	GND	GND	**Connect to PCB ground**
38	Reserved		**Reserved pin – Do not connect**
39	RF_GND	GND	**Connect to PCB ground**
40	RF	RF	**50 Ω RF Antenna Connection**
41	RF_GND	GND	**Connect to PCB ground**
42	GPS	GPS	**U.FL GPS Antenna Connector (on top)** Please see reference U.FL-R-SMT-1 from Hirose for more information about compatible coaxial cable. This connector provides power supply to the external active antenna.

6 Ordering Information

Part Number	Description	Package Type	Operating Temperature
TD1204	ISM SIGFOX™ gateway 128K Flash/16KRAM TCXO	LGA41 Pb-free	-30° to +75°C

The TD1204 ISM SIGFOX™ gateway module is available in several conditionings.

Please contact Telecom Design for more information.

7 Package Outline

Figure 2 illustrates the package details for the TD1204.

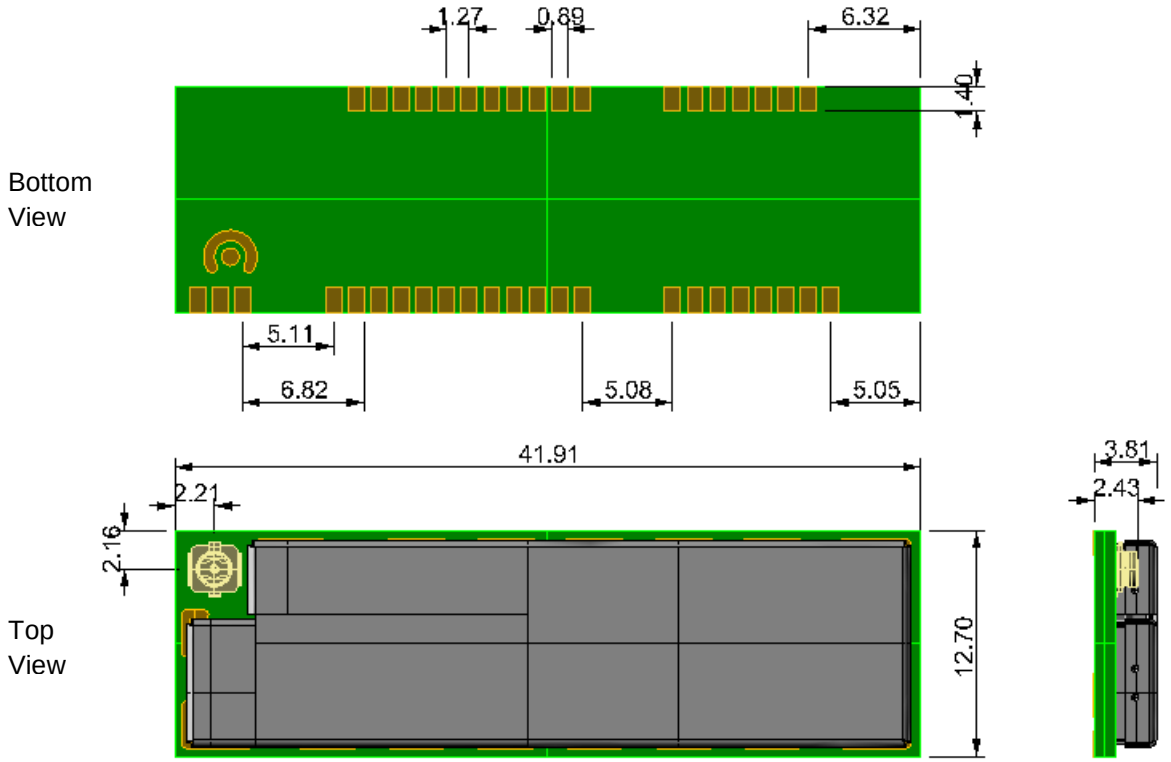


Figure 2. 41-Pin Land Grid Array (LGA)

Notes:

1. All dimensions are shown in millimeters (mm) unless otherwise noted.

8 PCB Land Pattern

Figure 3 illustrates the PCB land pattern details for the TD1204. (This footprint is also compatible with the TD1202).

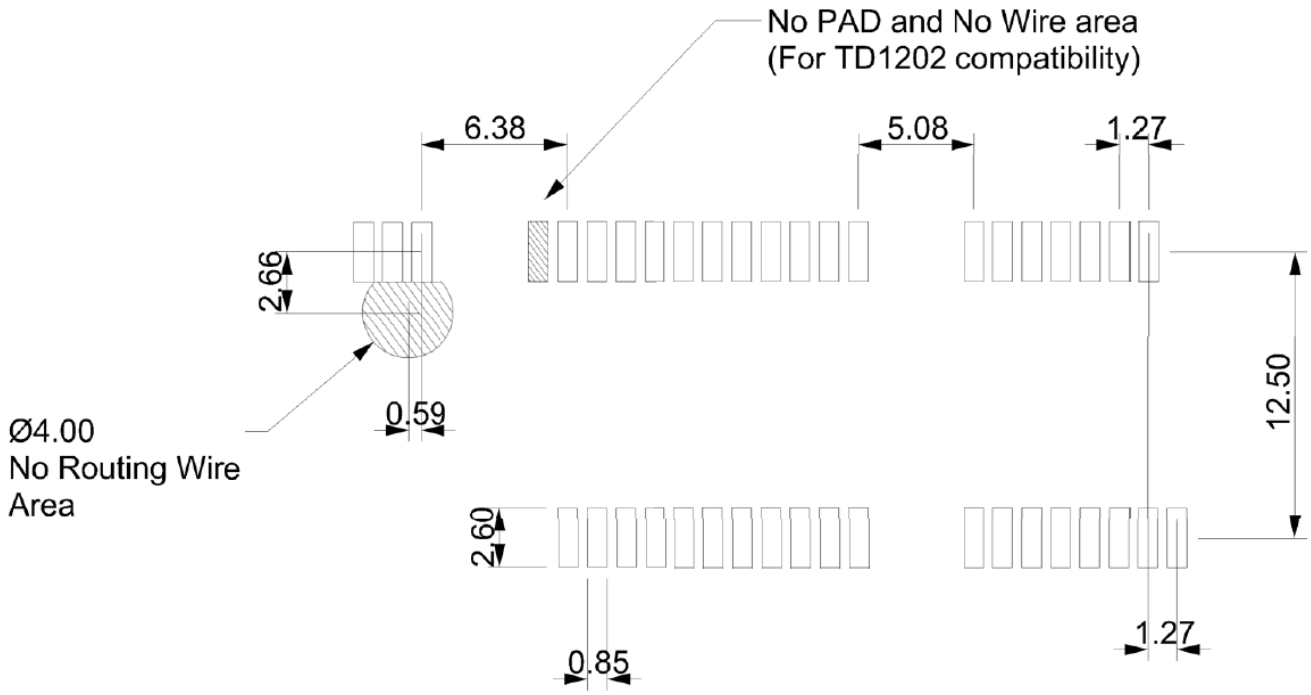


Figure 3. PCB Land Pattern

Notes:

1. All dimensions are shown in millimeters (mm) unless otherwise noted.

DOCUMENT CHANGE LIST

Revision 0.5

- Draft

Revision 0.6

- Changed contact information

Revision 0.7

- Corrected number of available ADCs and ADC0 pin ADC input number

Revision 0.8

- Removed USRx GPIO pins from the GPIO description section

NOTES:

CONTACT INFORMATION

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