GPS-/FM-/BT-Module TC6000

confidential information ***preliminary** specification*

1 INTRODUCTION

GNS, developer and manufacturer of module solutions for 10 years, presents the new **TC6000** series multifunction module which incorporates 4 wireless functionalities in one single device.

It integrates ***Global Positioning System*** (GPS)***, Bluetooth*** (BT) and ***FM transceiver*** for FM data reception (Traffic Message Channel) and audio transmission.

Features

- GPS, Bluetooth, FM receiver or transmitter in one module
- GPS tracking&navigation sensitivity -162dBm
- Assisted-GPS (A-GPS)
- GPS SAW filter and TCXO included
- Pulse Per Second (PPS) output for timing and synchronization applications
- Dedicated GPS processing
- Low load on host CPU
- Support of Bluetooth 3.0+EDR up to HCI level
- FM RDS encoder/decoder
- Analog & digital audio interfaces
- Host computer (PDA / Notebook / embedded /phone) drivers & API available
- Proven TMC solution (GPSTMC-API) available
- Low power consumption (210mW @ all cores in full operation)
- Only one single power supply (1.8V) needed
- Single electrical interface for GPS, Bluetooth, FM
- Miniature 36 pin module (10x9.3x2.3) mm

Evaluation Boards:

- TC6000 Starter Kit for testing on different host platforms
- Plug-in for TI OMAP 3530 EVM board

Applications

- Navigation
  - in-vehicle Navigation equipment, supports localization, traffic info (TMC) and wireless (Bluetooth) connectivity
  - dynamic Navigation
  - portable ("nomadic") devices
  - Netbooks, tablet PCs and mobile phones
- Timing
  - precision timing via GPS
  - Femto cell application
- Location based applications
  - GPS Logger
  - GPS Tracker
  - Security devices
  - Camera equipment

2 INDEX

3 DETAILED FEATURES

3.1 GPS Features

- Significantly improved TTFF at low signal power levels provides the consumer with a compelling GPS experience
- Improved acquisition performance down to –147 dBm to process position fixes in deep indoor conditions
- Reduced power consumption through improvements to RF architecture, software techniques, receiver core, and RF noise figure partitioning
- Improved tracking performance and minimized error in multi-path environments through increased IF bandwidth and higher sampling rates in tracking channels
- Integrated APM (advanced power management) performs automatic dynamic power saving dependent on the signal conditions. Up to 70% power savings at 1 update per second.
- GNS software drivers will provide one or more virtual COM ports to support multiple applications

3.2 Bluetooth Features

- Support of Bluetooth 3.0+EDR up to HCI level
- Supports typically 12.5 dBm Class1.5 TX power w/o external PA, improving BT link robustness
- Digital Radio Processor (DRP) single-ended 50 Ω I/O for easy RF interfacing
- Internal temperature detection and compensation ensures minimal variation in the RF performance over temperature
- Flexible PCM digital audio/voice interfaces
- Proprietary low-power scan method for page and inquiry scans, achieves page and inquiry scans at 1/3rd normal power

3.3 Bluetooth Link Features

TC 6000 supports all the features described in the Bluetooth specification 3.0, including:

- All lower layers up to HCI (Link Controller, Link Manager, host controller interface and UART transport layer)
- Scatternet: Up to three piconets simultaneously, one as master and two as slaves
- Up to seven active devices
- Up to two SCO links on same or different piconets
- Voice and audio over HCI
- All packet types
- Pairing, authentication, encryption, inquiry, inquiry-scan, page, page-scan, hold, sniff, park, M/S switch, broadcast, QoS, test mode, flow specification, and flush timeout functions
- Sound: All BT formats
- Class 1 to Class 3 Power control
- RSSI: range of -88 dBm to -20 dBm with 3-dB accuracy
- Adaptive frequency hopping: Hopping kernel supports several hopping sets and channel classification as either Master or Slave.

3.4 FM Features

- On-chip FM receiver and transmitter with RDS (and RBDS) support for both functions
- Digital Input/Output and analog audio output interface for transmit and receive
- FM can transmit or receive radio station signals, perform scans, and send RDS to host, while BT can be in any operational mode
- No simultaneous receive and transmit
- Compatibility with both European/US FM bands (87.5 MHz to 108 MHz)
- Digital I2S/PCM audio interface for stereo/mono with selectable master or slave, data/slot offset, data-width, etc.
- Multiple digital audio data path through BT PCM or FM I2S interface
- Maximally digital implementation (digital MPX signal and digitally-controlled RF AGC function)
- Receive capability via TX RF interface to find best FM channels for transmission, without requiring FM antenna

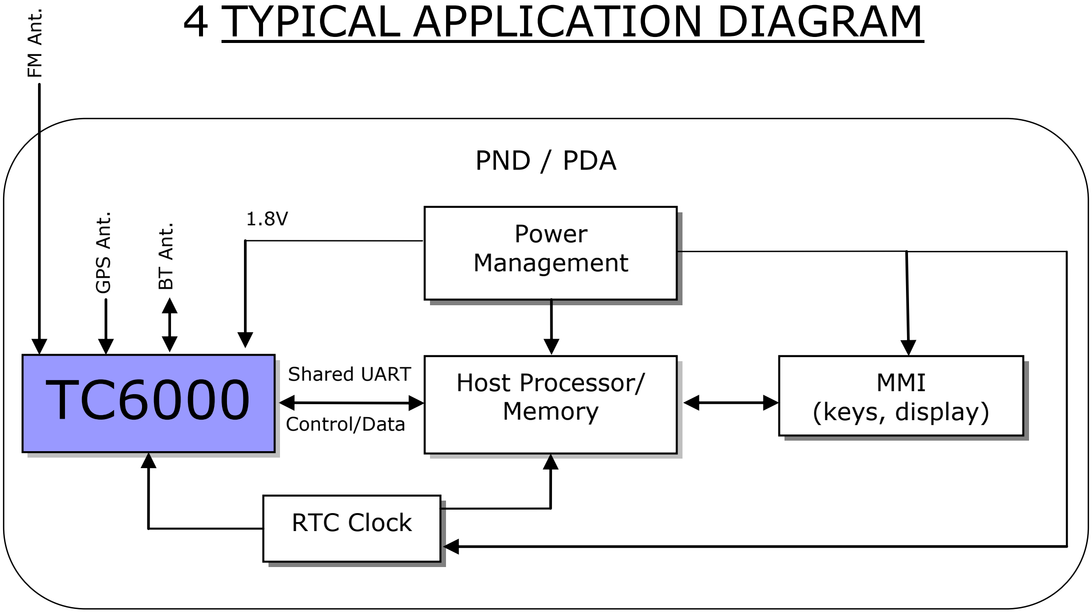
3.4.1 FM Radio Receiver Features

- Enhanced, full-featured FM receiver with best-in-class sensitivity level audio quality
- Frequency resolution: 50-kHz step tuner, fast, independent up/down function
- Supports primary standard audio sample rates: 32, 44.1, and 48 ksample/s
- Integrated RDS/RDBS features with fast PI matching and Block-B matching; 256 Bytes RDS FIFO
- Stereo/Mono switched/soft blend on signal condition
- Selectable 50-µs/75-µs de-emphasis filter
- Software selectable level for soft mute and stereo/mono blend level
- Internal tuned matching network
- Soft mute and programmable pause detect

3.4.2 FM Transmitter Features

- FM transmitter enables playing an audio file from either a handset or an FM Hi-Fi system:
  - Wide dynamic transmitter output power range to comply with FCC/ETSI
  - Flexible antenna interface
- Fully-integrated FM transmitter with complete FCC- and ETSI-compliant implementation
- Internally-generated digital MPX signal and RDS data with minimal communication to host
- RDS/RBDS data as program service or radio text message
- Automatic scrolling of text for PS display
- Configurable I2S/PCM sample-rates support all standard MP3 rates (48 kHz, 44.1kHz, 32 kHz, 24 kHz, 22.05 kHz, 16 kHz, 12 kHz, and 8 kHz with various bit-clock rates support, up to 6.144 MHz)
- Selectable 50-µs/75-µs de-emphasis filter
- Programmable output power
- Programmable channel resolution frequency (50 kHz, 100 kHz, or 200 kHz)
- Internally filtering to minimize cellular band interference
- Internally-generated digital MPX signal and RDS/RBDS data, with automatic text scrolling

4 TYPICAL APPLICATION DIAGRAM



5 SYSTEM REQUIREMENTS

TC6000 includes complete cores for 4 functionalities. It removes most of the processing load from the host:

- GPS is fully processed without any host power requirements,
- FM RDS is completely decoded
- Bluetooth is supported up to the HCI interface layer.

However there are some conditions that must be met:

5.1 High speed UART interface with HW-handshake

TC 6000 supports transport of all data streams through a single high speed UART.
Regarding hardware, the host CPU has to provide one high speed UART port with (RTS, CTS) hardware handshake, that can run at a minimum of 2Mbps and a maximum of 4Mbps.
This high speed interface transports a proprietary protocol.
GNS drivers will manage the splitting of the data streams and decode the proprietary protocol to:

- NMEA for GPS,
- GNS protocol3.5 for FM & RDS
- and HCI standard interface for Bluetooth

Drivers can be downloaded at http://www.forum.gns-gmbh.com/

5.2 Start up of TC6000

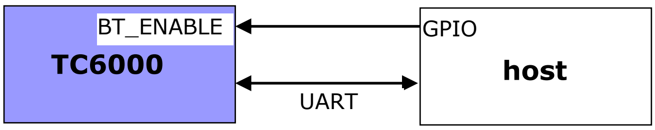
TC6000 works with a flexible firmware concept. Before starting up the function cores, a firmware transfer has to be performed. For this task, a non-volatile memory (ROM or flash) of at least 120kBytes is needed to store the firmware add-ons.
The firmware add-ons will be available as part of the GNS driver.
The GNS driver will automatically download this data to TC6000 whenever needed.

5.3 GPS

GPS almanach, ephemeris and clock time has to be kept in host memory during standby and off-times. The GNS driver manages this task in the background.

5.4 Enable line

One further I/O from the host will be needed as a master activity and reset control for the TC6000. This I/O will be supported by GNS drivers.



5.5 Real time clock (RTC)

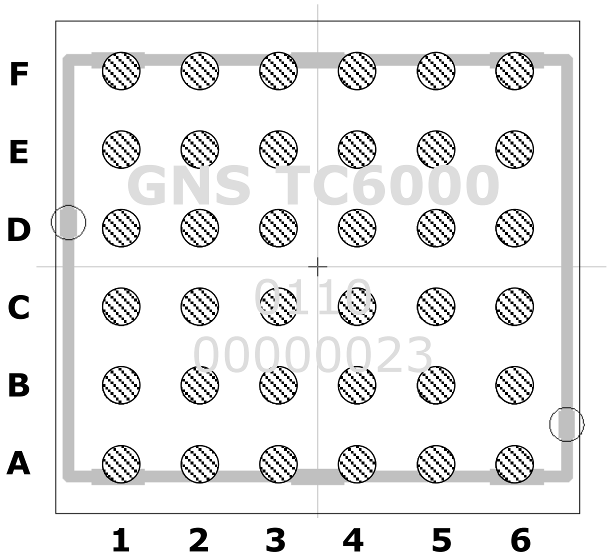
TC6000 includes a real time clock that will provide time information for GPS after an off-time. The clock signal of 32.768kHz is not on-module and has to be fed at pin *RTC_CLK* . Additionally, the clock signal is needed for some other chip-internal purposes. See chapter *RTC Connection* for more details.

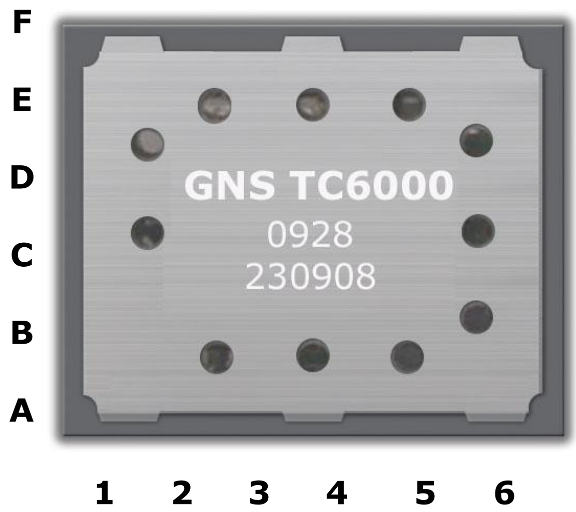
5.6 I/O levels

TC6000 cores and I/O sections work at 1.8V nominal. Please never apply any higher voltages as specified under absolute maximum ratings!
If TC6000 should be interfaced to a host that works with higher logic voltages, please add level shifters.

6 DEVICE PINOUT DIAGRAM

TOP VIEW





F	VDD_IO	GND	TX	N.U.	BT_ENABLE	BT_RF
E	VDD	GND	CTS	RX	RTS	GND_BT
D	BT_AUD_CLK	BT_AUD_FSYNC	BT_AUD_IN	BT_AUD_OUT	N.U.	FM_I2S_CLK
C	GPS_PPS	TCXO_CLK	GPS_TX	GPS_ENABLE	RTC_CLK	FM_I2S_IN
B	GPS_RF	GPS_GND	GPS_RX	GND_FM	GND_FM	FM_I2S_FSYNC
A	GPS_GND	GPS_GND	FM_AUD_R_OUT	FM_AUD_L_OUT	FM_TX_RF	FM_RX_RF
	1	**2**	**3**	**4**	**5**	**6**

NO	NAME	TYPE[1]	DESCRIPTION
Power-Management Signals			
E1	VDD	P	1.8V Power supply voltage
F1	VDD_IO	P	1.8V I/O power supply voltage
C4	GPS_ENABLE	I	Shutdown control for the GPS core
F5	BT_ENABLE	I	Shutdown control for the BT and FM cores
F2	GND	P	Common Ground
E2	GND	P	Common Ground
Clock Signals			
C2	TCXO_CLK	O	Output of internal TCXO
C5	RTC_CLK	I	Sleep clock input: 32.768 kHz. Fail-safe.
GPS Signals			
B1	GPS_RF	Ana	GPS RF input to the device
C3	GPS_TX	O	GPS UART TX
B3	GPS_RX	I	GPS UART RX
C1	GPS_PPS	O	GPS Pulse per second
A1	GPS_GND	Ana	GPS Ground
A2	GPS_GND	Ana	GPS Ground
B2	GPS_GND	Ana	GPS Ground
BT Signals			
F6	BT_RF	Ana	BT RX/TX Single-ended port
D1	BT_AUD_CLK	I/O	PCM/I2S clock
D2	BT_AUD_FSYNC	I/O	PCM/I2S frame synchronization
D3	BT_AUD_IN	I	PCM/I2S data input
D4	BT_AUD_OUT	O	PCM/I2S data output
E6	GND_BT	Ana	BT GND
FM Signals			
A5	FM_TX_RF	Ana	Single-ended FM RF-out
A6	FM_RX_RF	Ana	Single-ended FM RF-in
A3	FM_AUD_R_OUT	O	FM analog audio out (right)
A4	FM_AUD_L_OUT	O	FM analog audio out (left)
B6	FM_I2S_FSYNC	I/O	FM I2S frame sync line
C6	FM_I2S_IN	I	FM I2S data input
D6	FM_I2S_CLK	I/O	FM I2S clock line
B4	GND_FM	Ana	FM Ground
B5	GND_FM	Ana	FM Ground
Shared UART			
E4	RX	I	Shared UART RX from host
F3	TX	O	Shared UART TX from host
E5	RTS	O	Shared UART request to send to host
E3	CTS	I	Shared UART clear to send from host
Not Used Pins			
F4			Do not connect
D5			Do not connect
C2			Do not connect

(1) I = INPUT; O = OUTPUT; I/O = BIDIRECTIONAL; P = POWER PIN; ANA = ANALOG PIN.
DO NOT CONNECT N.U. PINS TO ANYWHERE ! MUST BE LEFT OPEN.

7 ELECTRICAL SPECIFICATION

Absolute Maximum Ratings		
Parameter	**Value**	**Unit**
Supply voltage range: VDD	–0.5 to 2.1	V
Supply voltage range: VDD_IO	–0.5 to 2.1	V
Input voltage to analog pins[1]	–0.5 to 2.1	V
Input voltage to all other pins	–0.5 to (VDD_I/O + 0.5)	V
Operating ambient temperature range	–40 to +85	°C
Storage temperature range	–55 to +125	°C

1. BT_RF, GPS_RF, FM_TX_RF, FM_RX_RF, FM_AUD_I/O
2. Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Recommended Operating Conditions					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
VDD	1.7	1.8	1.95	V	Power-supply voltage
VDD_IO	1.65		1.92	V	I/O power-supply voltage
Maximum ripple on VDD			60	mVpp	0 MHz to 0.1 MHz
			50	mVpp	0.1 MHz to 0.5 MHz
			30	mVpp	0.5 MHz to 1.7 MHz
			25	mVpp	1.7 MHz to 2.5 MHz
			15	mVpp	2.5 MHz to 3.3 MHz
			5	mVpp	Greater than 3.3 MHz

I/O characteristics					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
High level output voltage V_{OH}	0.8 * V_{DD}		V_{DD}	V	IOUT = 4 mA
	1,45		V_{DD}	V	IOUT = 0.4 mA
Low level output voltage V_{OL}	0		0.2*V_{DD}	V	IOUT = 4 mA
	0		0.2	V	IOUT = 0.4 mA
High level input voltage V_{IH}	0.65x VDD_IO		1.92	V	
Low level output voltage V_{IL}	0		0.35x VDD_IO	V	
I/O input impedance	1			MΩ	resistive
			5	pF	capacitive
Output rise & fall times t_r,t_f			10	ns	Digital I/O
Pull down current on BT_ENABLE and GPS_ENABLE	4	6	10	µA	
Rise fall time on BT_ENABLE and GPS_ENABLE			20	µsec	
Minimum width on BT_ENABLE and GPS_ENABLE			5	msec	

Current Consumption					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
general					
Current consumption in shutdown (BT + GPS)		10		uA	At +25°C
Total I/O current in shutdown			5	uA	At +25°C
Total current (BT + GPS+ FM)		121	133	mA	BT in EDR / GPS in acquisition / FM transmit mode
GPS engine					
GPS IDLE		5.64		mA	
GPS DEEP SLEEP		60	192	uA	
GPS ACTIVE (acquisition)		63	76	mA	NMEA frequency = 1/sec
GPS ACTIVE (tracking)		40	50	mA	NMEA frequency = 1/sec
GPS ACTIVE (tracking)			9.5	mA	NMEA frequency=1/sec,-130dBm,APM feature active
BT engine					
BT Idle current (ARM off)		4.5		mA	
SCO link HV3		14.1		mA	
eSCO link EV3 64Kbps		14.3		mA	
eSCO link 2-EV3 64Kbps		10.6		mA	
EDR full throughput		42.7		mA	
Sniff, 1 attempt, 1.28sec		135	180	µA	
Page or Inquiry Scan 1.28 s		415		µA	
Low power scan, 1.28 s interval		170		µA	
FM engine					
FM receiver mode current		12		mA	
FM transmitter mode full output level		14.3		mA	

Conditions: VDD_IN = 1.8 V, 25°C, BT : 4 dBm output power.

8 BLUETOOTH CORE

8.1 Bluetooth core description

The TC6000 Bluetooth core supports BT3.0 +EDR. It uses a state-of-the-art digital radio processor architecture and ensures stable operation without any alignment necessary.

8.1.1 Bluetooth receiver

The receiver uses near-zero-IF architecture to convert the RF signal to baseband data. Received signal from the external antenna is input to a single-ended LNA (low-noise amplifier). This signal is then passed to a mixer which down converts the signal to IF, followed by a filter and amplifier. The signal is then quantized by a sigma-delta ADC. The quantized signal is further processed to reduce the interference level.
The demodulator digitally down converts the signal to zero IF and recovers the data stream by an adaptive-decision mechanism. The demodulator includes EDR (enhanced data rate) processing with state-of-the-art performance. It includes a maximum-likelihood sequence estimator (MLSE) for improved performance of basic-rate GFSK sensitivity, and adaptive equalization to enhance EDR modulation.
New features include:

- The LNA input range is narrowed to increase blocking performance
- Active spur cancellation increases robustness to spurs

Bluetooth RF characteristics					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
Operating frequency range	2402		2480	MHz	
Channel spacing		1		MHz	
Input impedance		50		Ω	
Rx sensitivity	-91.5	-95		dBm	GFSK, BER = 0.1%
	-90.5	-94.5		dBm	Pi/4-DQPSK, BER = 0.01%
	-83	-87.5		dBm	8DPSK, BER = 0.01%
Tx power			12	dBm	Up to class 1.5

8.1.2 Bluetooth transmitter

The transmitter is an all-digital, sigma-delta PLL (ADPLL) based, with a digitally-controlled oscillator (DCO) at 2.4 GHz, as the RF frequency clock. The modulation is achieved by directly modulating the digital PLL.
The power amplifier is also digitally controlled. The transmitter uses Polar-Modulation technique. While the phase-modulated control word is being fed to the ADPLL, the amplitude-modulated controlled word is fed to the class-E amplifier to generate a Bluetooth standard compliant RF signal. TX output power is up to class 1.5

Bluetooth out of band emissions					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
Tx and Rx out of band emissions. Output = 10dBm			-100	dBm/Hz	76 to 108 MHz (FM)
		-150	-147	dBm/Hz	746 to 764 MHz (CDMA)
		-148	-145	dBm/Hz	869 to 894 MHz (CDMA1,GSM)
		-146	-143	dBm/Hz	925 to 960 MHz (E GSM)
		-142	-139	dBm/Hz	1.57 to 1.58 GHz (GPS)
		-143	-140	dBm/Hz	1.82 to 1.88 GHz (GSM)
		-143	-141	dBm/Hz	1.93 to 1.99 GHz (GSM,CDMA1,WCDMA)
		-143	-139		2.11 to 2.17 GHz (WCDMA)
		-70.5	-67	dBm	30kHz to 1GHz
		-51.5	-41	dBm	1.0 to 12.75 GHz

8.1.3 Bluetooth Low power schemes

The TC6000 device includes a mechanism that handles the transition between operating mode and deep sleep low-power mode. The protocol is managed via the UART and is known as the HCILL (HCI Low-Level) power management protocol.
This protocol is already implemented in the *BlueZ* BT-stack for Linux / Android operating systems.

9 GPS CORE

9.1 GPS core description

The TC6000 GPS core is a high performance, low power GPS receiver with integrated RF frontend. Due to high input sensitivity it can work directly with a passive antenna.
The very short TTFF (Time To First Fix) and improved acquisition performance at low signal power levels is achieved through an enhanced receiver core architecture.
The improved RF architecture and software techniques reduce the average power consumption.
Minimized error in multi-path environments is achieved through increased IF bandwidth and higher sampling rates in tracking channels.
TC6000 supports APM (adapted power management) schemes to lower the average power of the GPS core to below 20mW.
Supply of aiding information like ephemeris, almanac, rough last position and time and satellite status will reduce time to first fix significantly and improve the acquisition sensitivity.

GPS characteristics					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
general					
Frequency		1575.42		MHz	GPS L1; C/A code
Output data frequency	1	1	2	1/sec	Configurable data rate
Tracking&Navigation sensitivity			-162	dBm	
Acquisition sensitivity			-147	dBm	autonomous
			-155	dBm	assisted
TTFF hotstart			1	sec	@-130dBm
TTFF hotstart			10	sec	@-155dBm
TTFF coarse time assisted			18	sec	@-155dBm
TTFF autonomous cold start		34		sec	@-130dBm
TTFF autonomous cold start		45		sec	@-142dBm
Number of channels tracking		16			
Number of acquisition channels		40			
GPS IDLE		5.64		mA	
GPS DEEP SLEEP		60	192	uA	
GPS ACTIVE (acquisition)		63	76	mA	NMEA frequency = 1/sec
GPS ACTIVE (tracking)		40	50	mA	NMEA frequency = 1/sec
GPS ACTIVE (tracking)			9.5	mA	NMEA frequency=1/sec, -130dBm,APM feature active
other					
1PPS pulse duration		1		msec	
1PPS time jitter			100	nsec	Pulse rising edge deviation from expected pulse time, measured in a 300 seconds interval with full 3D fix
1PPS rise and fall time			10	nsec	10%..90%
1PPS output impedance	-	10kΩ//20pF	-		
TCXO output frequency		38.400		MHz	±2.5ppm

TCXO output impedance		1MΩ//5pF		-	tbd
accuracy					
Static position error CEP68	-	2	-	m	**Normal open sky in Field** Horizontal position accuracy using open sky roof-top antenna
Static position error CEP95	-	3	-	m	**Normal open sky in Field** Horizontal position accuracy using open sky roof-top antenna
Static position error CEP68	-	-	2	m	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level
Static position error CEP95	-	-	3	m	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level
dynamic position error CEP68	-	-	3	m	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level
dynamic position error CEP95	-	-	4	m	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level
velocity error CEP68	-	-	0.1	m/s	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level
velocity error CEP95	-	-	0.7	m/s	**Simulator feed ,** IONO and TROPO errors oN at -130 dBm power level
ITAR limits					
Operation altitude	-5,000	-	18,288	m	
Operation velocity	-	-	514	m/s	
Operation acceleration	-	-	-	m/s^2	No limit set

9.2 GPS power management features

Power management schemes implemented for any GPS/A-GPS system requires an optimally tuned performance for both accuracy of the position fixes and the average power consumed for best user experience. TC6000 architecture achieves both these aspects, by providing flexibility and design choices for the system integration based on wide range of use cases and leveraging on the proven silicon methodologies. Also TC6000 can provide position, velocity and time (PVT) measurements without any host loading. This coupled with the built-in power management option reduces the overall system power budget.
Power management features:

- APM feature provides overall GPS system power consumption of 17mW in tracking mode under open sky conditions
- Power management options that allows operation in typical signal conditions and deep sensitivity modes
- Inbuilt adaptive algorithm to provide best position accuracy and best power savings based on the user environment (urban canyon, open sky, semi urban etc)

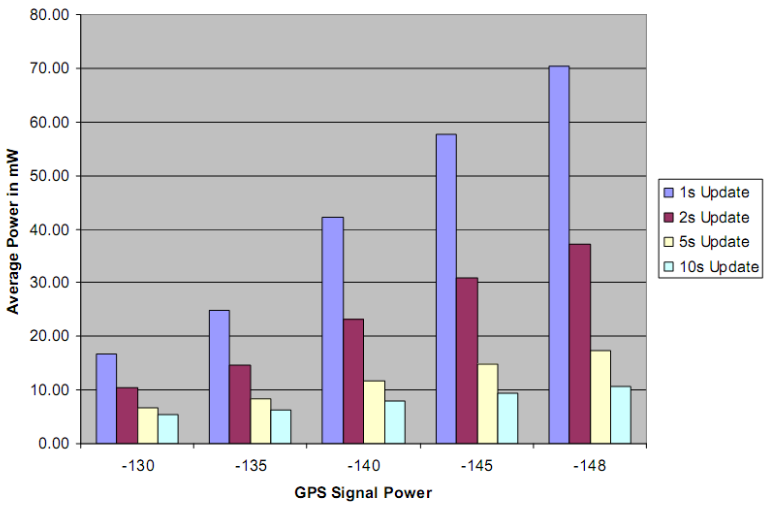
- Can provide PVT solution without any load on the host. This reduces the overall system power further.
- Programmable position update rates. Max of 2 Hz update rate.

9.2.1 Power states for single location fix solutions

Applications involving the single fix (E-911, accessing catalog data like restaurants, tourist attraction etc, or for personalized services like buddy finder, query the asset being tracked, map browsing based on current location) require single fix with varied quality of service (accuracy and time to first fix). For single fix solutions, the GPS core can be set to very low power state DEEP SLEEP.
Single fixes can either be assisted or autonomous depending on the network service provider.

ACTIVE, IDLE and DEEP SLEEP are host software driven states. The host can command the receiver to enter different SW driven states using NMEA command messages.

9.2.2 Power states for continuous location fix



For navigation or other tracking scenarios like asset tracking, geo fencing, child tracking, fleet management etc., a continuous position update is required. Based on the update rate "APM tracking" mode or "APM rapid reacquisition" mode schemes can be used. The APM modes will be activated via an NMEA command.
APM mode is based on temporarily deactivating parts of the GPS engine when signal conditions are good. (open sky conditions).
The graph shows typical power consumptions with *APM Tracking Mode* activated. The current consumption is as low as 9.5 mA even for a 1-second update rate. *APM Tracking Mode* will automatically adapt it's power requirements to the signal conditions. When entering a more difficult signal environment, the GPS engine will automatically switch to a higher or full power mode.

APM mode will be activated through a NMEA command message.

9.3 GPS almanac and ephemeris data

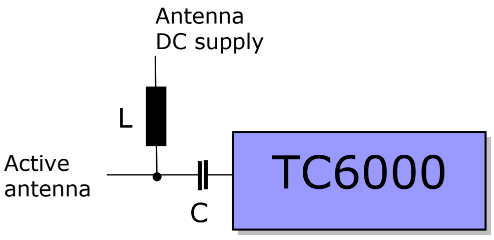
For quick re-acquisition of the GPS after off-times, the GPS engine should have access to almanac and ephemeris data. For TC6000, these data have to be held in the host non-volatile memory. GNS drivers will automatically store this data whenever there's an update. When the GPS is powered-up again, the data will be transferred to TC6000 to allow a quick re-acquisition.

9.3.1 Assisted GPS (A-GPS)

- The GNS TC6000 module allows using assisting data to perform quick starts without having any stored data available. A-GPS feature improves the Time To First Fix (TTFF) dramatically, because the time for downloading ephemeris data can be totally saved. With the help of injected aiding data, TTFF can be as short as 3 seconds from a cold start situation.
- A-GPS is especially useful when location fixes are needed only from time to time or when starting locations are changed during shutdown. In these situations, a GPS receiver can not rely on stored data and will need to receive all data telegrams from the satellites.
- Furthermore, A-GPS can improve the start (acquisition) sensitivity of receiver. Without aiding data, the receiver must gather the ephemeris data from the satellites, which might be impossible under weak signal conditions. Using aiding data in conjunction with an coarse time information, the receiver can compute the SV positions and can start calculating the position immediately. This improves the effective acquisition sensitivity by ~15..20dB.

9.4 GPS antenna

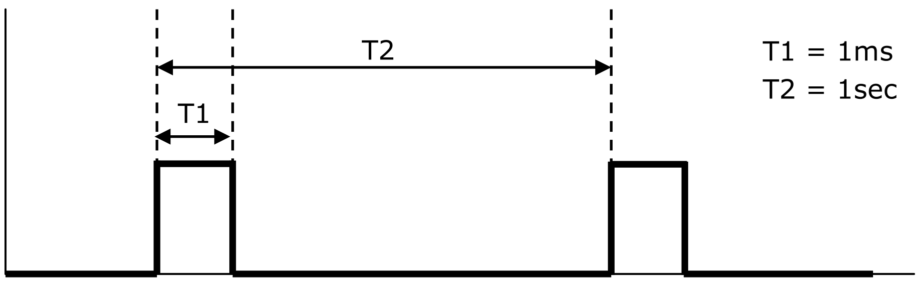
TC6000 contains all input circuitry needed to connect directly a passive GPS antenna. Dependent of the application patch- or chip antennas or combo antennas (combination of GPS and Bluetooth) can be used. However, if there is a long wire between TC6000 GPS RF input and antenna, there should be an LNA (on the antenna side) to compensate cable losses ("active" antenna). For active antenna configuration, the antenna supply DC must be blocked from the antenna signal line with an inductor (270nH) and a capacitor of 100pF.



More information about connecting and implementing a GPS antenna to an application PCB, refer to [2] **GPS Antenna Connection Design Guide.**

9.5 Pulse Per Second (PPS)

TC6000 provide a so called Pulse Per Second (PPS) for timing purposes. After calculation of a 3D position fix, the PPS signal is accurately aligned to the GPS seconds boundaries. The pulse generated is approximately 1 millisecond in duration and the repetition rate is 1 second.



9.6 NMEA Data

TC6000 drivers provide NMEA (National Marine Electronics Association) 0183 compatible data. The following table shows the available NMEA sentences

NMEA data rate is 1/second or 2/second. All active NMEA sentences are sent at the selected rate

NMEA available sentences	
type	**content**
$GPRMC	Recommended Minimum Navigation Information
$GPGGA	Global Positioning System Fix Data, Time, Position and fix related data for a GPS receiver
$GPGSV	Satellites in view
$GPGLL	Geographic Position - Latitude/Longitude
$GPGSA	GPS DOP and active satellites
$GPVTG	Track made good and Ground speed

10 FM FUNCTIONAL BLOCKS

The FM Core supports receive and transmit functionality alternatively.
It can be switched between the two functionalities via software.
Both functionalities provide full RDS support and analog and digital audio.

10.1 FM RECEIVER

10.1.1 FM receiver RDS decoder

The FM core includes digital and analog stereo audio output interfaces:

10.1.2 FM receiver audio paths

The FM core includes digital and analog stereo audio output interfaces:

- FM analog audio output is routed to the FM_AUD_L_OUT & FM_AUD_R_OUT pins.
- FM digital audio output is shared with the BT audio interface. See chapter digital audio for more information
- FM digital audio can be directly routed to the Bluetooth digital audio input to provide A2DP audio transmission of FM audio content.

10.1.3 FM receiver characteristics

For all FM bands: 87.5 to 108 MHz Europe/USA, 76 to 91 MHz Japan. BT in standby mode.
Maximum load on analog audio outputs: R_L = ≥ 30kΩ, C_L ≤ 20pF

Characteristics	Min	Typ	Max	Unit	Note
Audio output impedance			50	Ohm	FM enable during auto-search
	50			kOhm	FM function disable and when muted
RF Rx input impedance		50		Ohm	With external matching circuitry
Frequency step	50			kHz	
Wide-band Spurious Response Rejection	40		1.2	dB	Entire FM band, RDS off, SΔf = 75kHz, IΔf = 75 kHz, measured at ±400 kHz
RF input power level			105	dBµV	Max input power
AM Suppression	40			dB	For V_{IN} ≤ 1 mV (1)
Maximum SNR	57	60		dB	Mono — V_{IN} = 1mV, f_{mod} = 1 kHz , Δf= 22.5kHz m = 0.3, BAF = 300Hz to 15kHz, L=R De-emphasis= 50 µs
	53	56		dB	Stereo
RDS Sensitivity		20	25	dBµV	For RDS deviation of 1.2 kHz. 95% of blocks decoded with no errors, taken over 5000 blocks
		15	20	dBµV	For an RDS deviation of 2kHz
Sensitivity		0	5	dBµV	f_{mod} = 1 kHz, Δf= 22.5kHz , A-weighted (S+N)/N = 26 dB (BW of 300 Hz to 15kHz) De-emphasis= 50 µs
RX setting time			5	ms	Channel switch, synthesizer lock time
			8	s	Overall band search time (200 channels)
			100	ms	Host command to response

(1) f_{mod} = 1 kHz (input tone) , Δf= 22.5kHz (Frequency of input signal), m = 0.3, BAF = 300Hz to 15kHz, L=R De-emphasis= 75 µs measured at analog or I2C audio outputs. Maximum load on analog audio outputs: RL = ≥ 30kΩ, CL ≤ 20pF

10.1.4 FM Rx Audio Characteristics

Characteristics	Min	Typ	Max	Unit	Note
Total harmonic distortion		0.4%	0.8%		V_{IN} = 1mV, L = R, de-emphasis= 50 µs
		0.9%	1.5%		V_{IN} = 1mV, L = R, de-emphasis= 50 µs, Δf=75kHz, f_{mod} = 3 kHz, stereo
		0.5%	1.0%		V_{IN} = 1mV, L = R, de-emphasis= 50 µs, Δf=75kHz, f_{mod} = 1 kHz, mono
Audio Bandwidth (-3dB points)	20		15k	Hz	f = 22.5kHz, Δ V_{IN} = 1mV, pre-emphasis 50 and 75 µs
Audio Output Level	60	75	90	mV ms	V_{IN} = 1mV, f_{mod} = 1 kHz(input tone), Δf= 22.5kHz (Frequency of input signal), m = 0.3, BAF = 300Hz to 15kHz, L=R
Pilot Suppression (measured at audio outputs)	46			dB	Δf= 75kHz, f_{mod} = 1 kHz

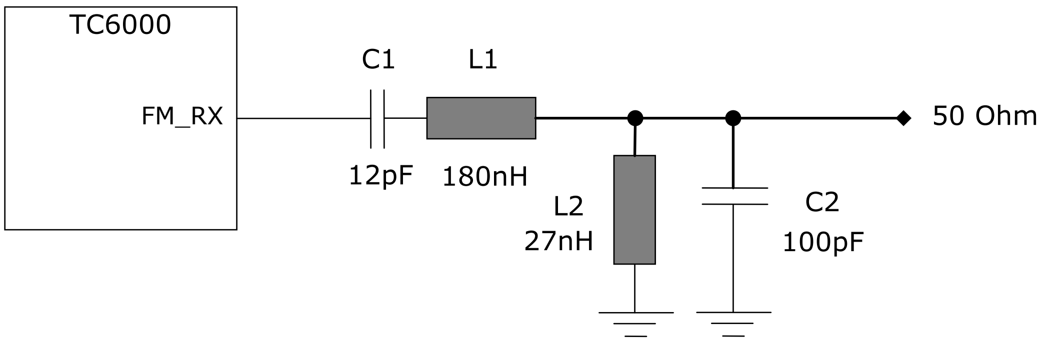
10.1.5 FM Rx Signaling Detection

Characteristics(1)	Min	Typ	Max	Unit	note
RSSI Step size		1.505		dBµV	
RSSI accuracy		±3		dB	
IF counter length		7		bit	Number of bits for IF indication
Minimum strength	5	12	18	dBµV	Minimum input voltage for correct IF indication
Audio level at which a pause is detected	-21		-12	dB	Relative to 1-kHz tone, 22.5 kHz deviation, 50-µs de-emphasis, 4 values in 3-dB steps
Audio pause duration	20		40	ms	4 values
Audio spike rejection during pause period			5	ms	Bursts of audio (during pause period) that are over the threshold are ignored, if cumulatively less than stated figure

(1) f_{mod} = 1 kHz (input tone) , Δf= 22.5kHz (Frequency of input signal), m = 0.3, BAF = 300Hz to 15kHz, L=R De-emphasis= 75 µs

10.1.6 FM receiver RF input path

For the optimal FM RX performance the following Filter-Network is highly recommended:



parts list				
	value	**package**	**manufacturer**	**comment**
C1	12pF	402	many	
C2	100pF	402	many	
L1	180nH	603	many	Q≥30
L2	27nH	402	many	Q≥30

10.2 FM TRANSMITTER

The FM core can be switched to transmitter functionality which can be used to send audio to a car stereo or other FM receiver via FM. The broadcast of very short distance transmissions is allowed in many countries, but special care must be taken to keep national and international regulations. Depending on the antenna construction, the output power level may differ from the set power level. It is absolutely necessary to check the transmission power level of the finalized device before bringing it to market to avoid infringements of telecommunication regulations.

10.2.1 FM transmitter legal notice

Please follow the national and international regulations regarding the power levels and duty cycles of FM transmission.

10.2.2 FM transmitter RDS encoder

The transmitter supports the RDS modulation of the FM signal. This feature can be used to push your device name to the car stereo display, for example.
The RDS content will be defined via the software interface.

10.2.3 FM transmitter audio path

The FM core uses a digital I2S interface for audio input with two options that are selected via the software interface:

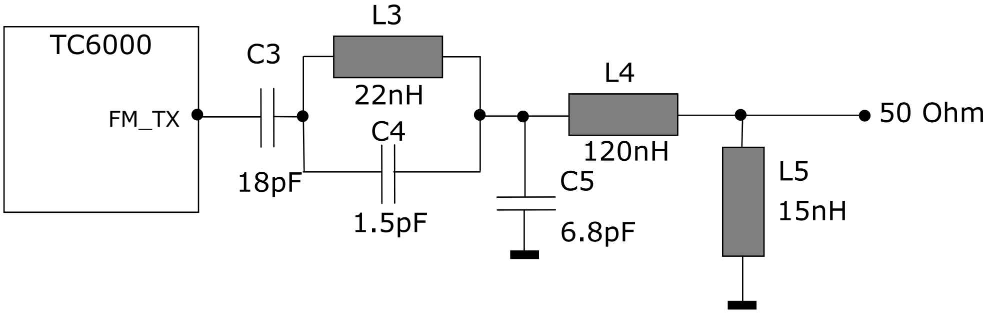
- FM digital input is fed into FM_I2S_CLK, FM_I2S_IN, FM_I2S_FSYNC pins
- FM digital audio input is fed into the shared FM and BT audio interface. See chapter *digital audio* for more information.

10.2.4 FM transmitter settings

The FM transmitter settings like on/off, output power setting, FM carrier frequency are controlled via the software interface.

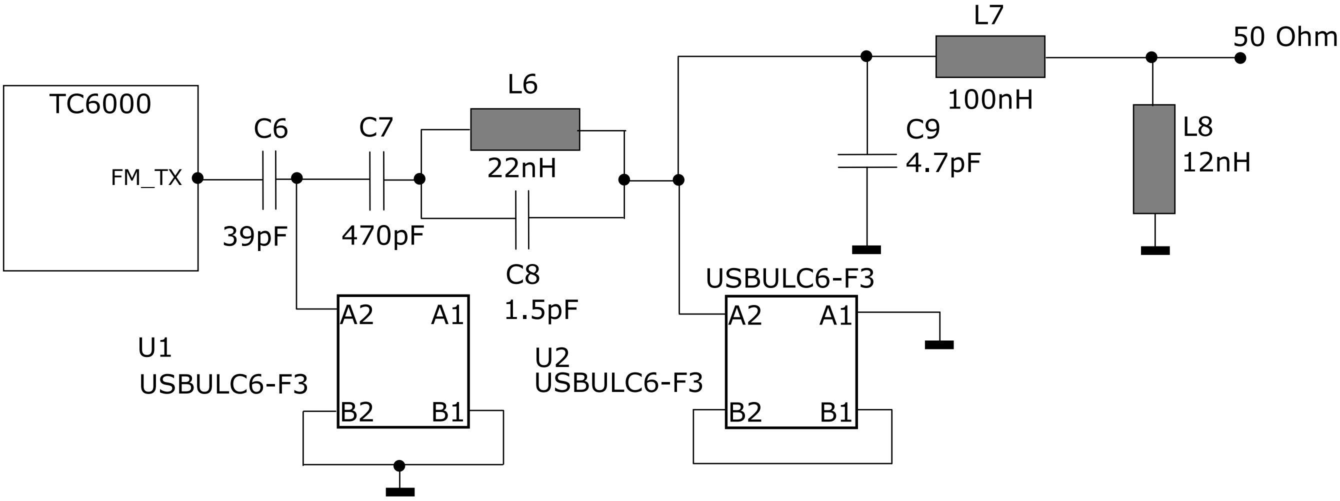
10.2.5 FM transmitter output path

Matching network to meet out-of-band emissions in cellular bands.



	value	package	manufacturer	comment
C3	18pF	402	Murata	GRM1555C1H180JZ01
C4	1.5pF	402	Murata	GRM1555C1H1R5CZ01
C5	6.8pF	402	Murata	GRM1555C1H6R8DZ01
L3	22nH, Q≥30	402	Murata	LQW15AN22NG00
L4	120nH, Q≥30	402	Murata	LQW15ANR12J00
L5	15nH, Q≥30	402	Murata	LQW15AN15NG00

Matching network to meet IEC ESD standard and out-of-band emissions in cellular bands.



	value	package	manufacturer	comment
C6	39pF	402	Murata	GRM1555C1H390JZ01
C7	470pF	402	Murata	GRM1555C1H471JA01
C8	1.5pF	402	Murata	GRM1555C1H1R5CZ01
C9	4.7pF	402	Murata	GRM1555C1H4R7CZ01
L6	22H, Q≥30	402	Murata	LQW15AN22NG00
L7	100nH, Q≥30	402	Murata	LQW15ANR10J00
L8	12nH, Q≥30	402	Murata	LQW15AN12NG00
U1	USBULC6-F3	Flip Chip	STMicroelectronics	ESD-Protection
U2	USBULC6-F3	Flip Chip	STMicroelectronics	ESD-Protection

10.2.6 FM TX Characteristics

Characteristics(1)(2)(3)(4)		min	typ	max	unit	note
Settling time				40	ms	Frequency switch
Frequency accuracy				±10	kHz	
Channel spacing		50	100	200	kHz	User configurable
Output power	Max level	117	118		dB/µV	Maximum output power when driving into R_{load} = 2KΩ, L = 120 nH Q>30. All Frequenccies, TX = ON, L = R = 0(no modulation), 0dB internal gain
	Flatness			±2	dB	
	Range		28		dBm	
Composite deviation				±75	kHz	L = R, 75mVrms, stereo enable
Pilot deviation		8%		10%		Relative to max peak deviation. Adjustable relative to audio path
Audio input bandwidth		20		15000	Hz	
Stereo channel separation		30	40		dB	
Audio total harmonic distortion			0.1	1	%	75 kHz deviation, 6.75 kHz pilot, modulation = 1kHz
Audio SNR		60	63		dB	22.5 kHz deviation, Mono I²S audio SNR ≥ 57 dB
		56			dB	22.5 kHz deviation, Stereo I²S audio SNR ≥ 57 dB
Audio spurious products with respect to 1-kHz tone				-60	dBc	Deviation of 22.5kHz, 1-kHz tone, L = R, BAF = 300 Hz to 15 kHz, f_{TX} = 76 to 108 MHz, 50-µs pre-emphasis
In-band spurious emission				0	dBc	0 to ±75 kHz offset; Peak deviation 75kHz, Audio tone 1kHz, pilot = 6.75kHz
				-12.2		±120 kHz offset
			-30	-25		±200 kHz offset
Occupied bandwidth				-20	dBc	±100 kHz offset from channel
TX noise floor				-140	dBm/Hz	850 to 2400MHz
Out-of-band spurious emission (at maximum power)				-102	dBm	746 to 764 MHz
				-109		869 to 894, 925 to 960, 1805 to 1880, 1930 to 1990MHz
				-106		1570 to 1580 MHz
				-96		2110 to 2170MHz
				-110		2400 to 2483.5 MHz (BT band)
Max deviation				100	kHz	Configurable, if local conditions permit

(1) f_{mod} = 1 kHz (input tone) , Δf= 22.5kHz (Frequency of input signal), m = 0.3, BAF = 300Hz to 15kHz, L=R De-emphasis= 75 µs
(2) Measured to EN55020 standards
(3) FM TX antenna must have Q≥30
(4) ESD device present on TX output

11 POWER MANAGEMENT

The TC6000 module requires a single 1.8V power supply. The 1.8V at the VDD pin supplies all cores (GPS+BT+FM) with the voltage. The 1.8V at VDD_IO pin supplies the digital I/Os with voltage. **No signals are allowed on the device I/Os in the absence of VDD_IO voltage** because the most I/Os are **not** fail-safe. Not fail-safe means that the pins will draw undefined current from an external voltage applied to the pin, when no I/O power is supplied to the device. Only exception is RTC_CLK.

11.1 Power-Up/Power-Down Sequence in Shared UART Mode

The TC6000 power-up procedure is triggered by setting the BT_ENABLE pin to high. The GPS_EN pin must be kept low. The BT_ENABLE pin must be connected to a host I/O to enable the software drivers to perform a proper start up sequence.
The FM and GPS core can be shutdown via software commands to save more power.

1. The GPS_EN pin must be kept low.
2. I/O voltage (VDD_IO) and supply voltage (VDD) should be available before pulling the pin BT_ENABLE high. Internal pull-downs are provided on the Enable pins to avoid false start-ups.
3. The RTC_CLK must be available before BT_ENABLE pin is pulled high.

11.2 Shutdown and Reset

The low BT_ENABLE signal puts the TC6000 into an ultra–low power (shutdown) mode and also performs an internal reset to the device. The Enable signal rise time must not exceed 20µs. GNS drivers will safely control the BT_ENABLE to wakeup the TC6000 after off times or after suspend.

12 RTC CLOCK

The RTC_CLK or slow clock is a free-running clock that is supplied from an external clock source. It is connected to the RTC_CLK pin on the TC6000, and is a digital square wave signal in the range of 0 V to 1.8 V (nominal). All cores (GPS, BT and FM) on the TC6000 share the same RTC_CLK. The slow clock frequency is 32.768 kHz. RTC_CLK has multiple functionalities:

- Used to maintain GPS time between sleep intervals
- For clock frequency detection at power-on reset, before TCXO_CLK is available
- For FM core functionalities

Digital RTC Requirements					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
Input slow clock frequency		32.768		Hz	
Input slow clock accuracy			±200	ppm	Initial + temperature + aging
Input transition time			100	ns	t_R/t_F: 10% to 90%
Frequency input duty cycle	20%	50%	80%		
Phase noise			–125	dBC/Hz	At 1 kHz offset
Frequency jitter			1	Hz	Integrated over 300 Hz to 15 kHz
V_{IH}	0.65x VDD_IO		VDD_IO	V	Slow clock input voltage limits
V_{IL}	0		0.35x VDD_IO	V	Slow clock input voltage limits
Load capacitance			10	pF	Capacitance on RTC_CLK pin
Load resistance			1	MΩ	Resistance on RTC_CLK pin

13 HARDWARE HOST INTERFACE

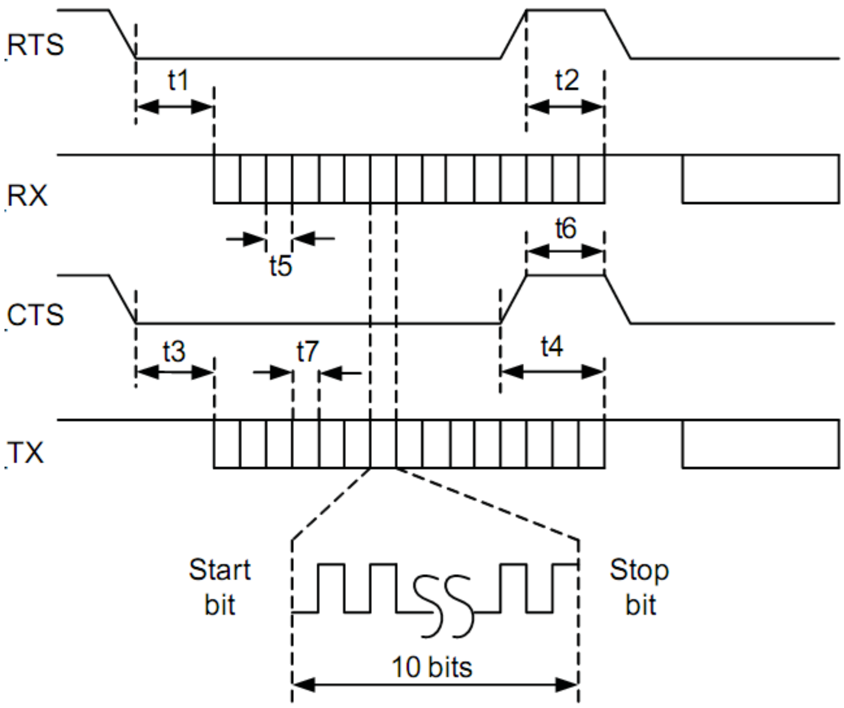
TC6000 allows two different concepts for interfacing to a host processor.
The ***shared UART*** concept needs only a single physical interface (a high speed, handshaked UART) to transport all data and control information. This interface is supported by the GNS drivers for Windows CE.
The second concept uses ***two UART***s, one high speed UART with handshake for the Bluetooth communication and one "low" speed UART that supports GPS. The two UART concept is preferred for Linux / Android systems.

Note: For the high speed UART, it is of importance that the UART system (HW and drivers) are able to transport high data rates (up to 4MBit/s) without any data losses.
Any data loss breaks the communication flow and requires a reset of TC6000.

One or two additional GPIO lines are needed to control the enable line of TC6000.

13.1 UART specifications

High speed UART Timings:



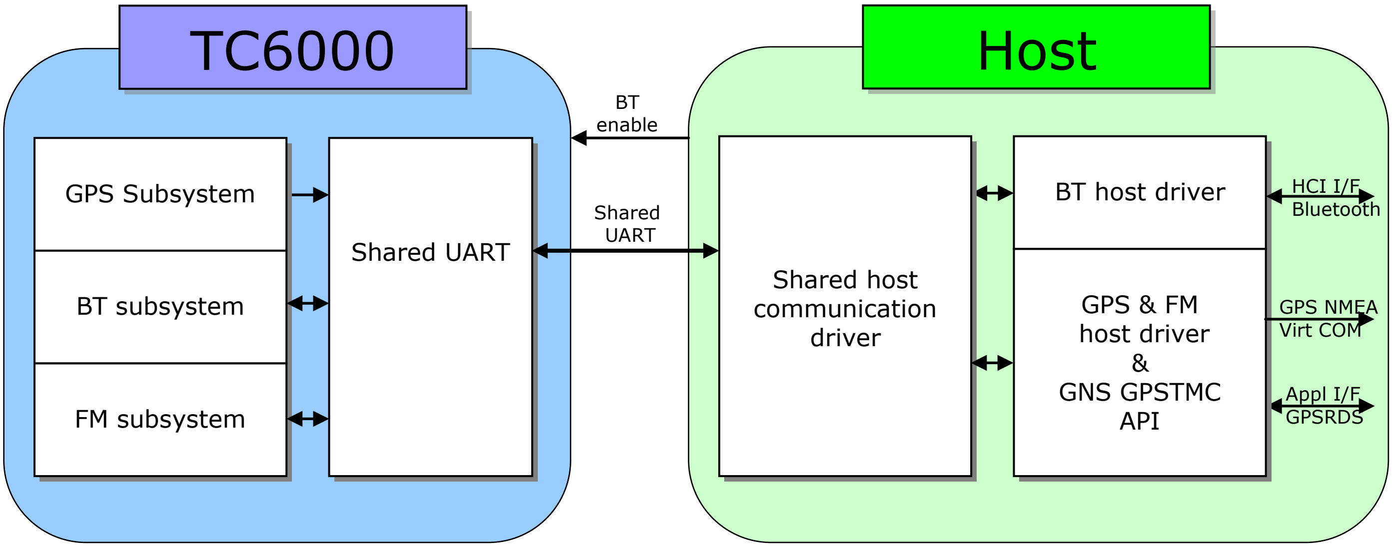
Picture 1

High speed UART data					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
Baud rate		115.2		kbps	Start value after reset
Baud Rate	(37.5)	>2000	4000	kbps	A rate of more than 2MBit is needed to perform fast start-up and high data rates on BT
Data format		8 N 1			8-Bit no parity 1 stop bit
t5 and t7			-2,5% to +1,5%		Baud rate accuracy
t3	0	2		ms	CTS low to TX_DATA on
t4			1	byte	CTS high to TX_DATA off
t6	1			bit	CTS High Pulse Width
t1	0	2		ms	RTS low to RX_DATA on
t2			16	bytes	RTS high to RX_DATA off
t_{rise} / t_{fall}			25	ns	Rise and Fall times (10%-90%)

Low speed (GPS-) UART data					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Note**
Baud rate		115.2		kbps	Start value after reset
Baud Rate	9.6		400	kbps	
Data format		8 N 1			8-Bit no parity 1 stopbit
t5 and t7			-2,0% to +1,5%		Baud rate accuracy
t_{rise} / t_{fall}			25	ns	Rise and Fall times (10%-90%)

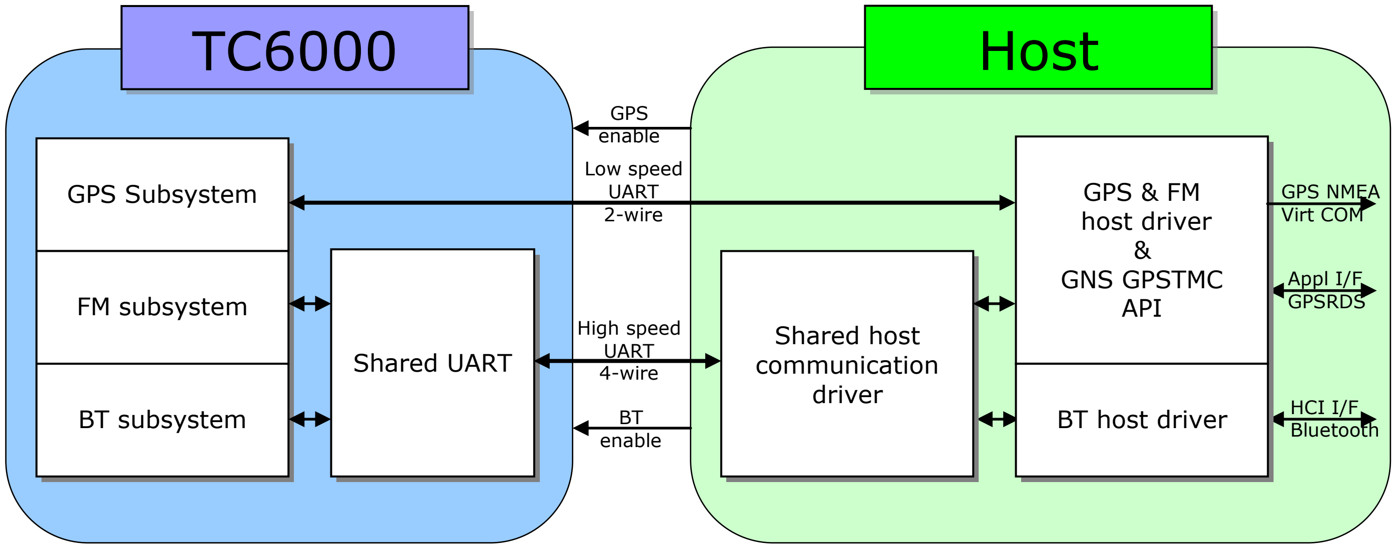
13.2 Fully Shared Host Interface Connection through UART:

In this configuration, all three cores share the same interface to communicate with the host. It's a four wire interface (RX, TX, RTS, CTS). TC6000 can support a maximum baud rate of 4Mbps. The UART should be operated at a minimum of 2Mbps to ensure a proper operation.
In this configuration GPS and FM cores maybe shutdown via software command to save some energy. GPS_ENABLE pin must be tied to ground.



13.3 Shared UART for BT/FM & dedicated 2nd UART for GPS:

In this configuration BT and FM use a four-wire UART interface (RX, TX, RTS, CTS) with a maximum baud rate up to 4Mbps.
GPS uses a two-wire interface with no flow control (null modem connection). The 2nd UART for GPS supports speed up to 400kbps.
The BT_ENABLE and GPS_ENABLE pins must be connected to a host GPIO to allow controlling the subsystems of TC6000 separately. GNS drivers support the control via software.
The FM Enable state is controlled through software.



13.4 GPS UART Interface details

The UART interface is used to send/receive control information , data and wrapped NMEA messages to the host.
GNS provides driver software to support NMEA through one or more virtual COM ports.

The default baud rate after power-up the device is 115.2 kbps, regardless of the clock frequency supplied to the device. The maximum baud rate deviation supported is ±2%. After boot-up, the host can change baud rate.

14 HOST INTERFACE PROTOCOL&DRIVERS

TC 6000 allows to transport multiple functionalities over a single high speed UART as described before.

This data transport layer is realized through a proprietary low level protocol.

To gain access to the data and control over the function blocks, a set of drivers is needed to split the data to the 3 functionalities and to translate the proprietary protocol to standard protocols:

The table shows an overview of available drivers (December 2010) and their interfacing to the host

Host application interfaces					
	Availability				
Functionality	**Drivers Linux**	**Drivers WinCE**	**Host interface**	**Host interface protocol**	**note**
Configuration data for all function blocks of TC6000	1/2011	1/2011	-	Registry data	Configuration data is stored as registry entries, data will be transferred to TC6000 by the GNS drivers
Bluetooth	YES	1/2011	COMport	HCI	The HCI interface must be linked to a Bluetooth stack to perform the desired BT-services
GPS data / control	YES	1/2011	Virtual COM port(s)	NMEA interface	One ore more virtual COM ports to run one or multiple GPS clients
FM Rx control	On request	1/2011	GNS GPSTMC-API	Library functions	The GNS GPSTMC API exposes an application interface for automatic TMC reception, preprocessing, station management, TMC-CA management.
FM RDS data and TMC	On request	1/2011	GNS GPSTMC-API	Library functions	The GNS GPSTMC API exposes an application interface for automatic TMC reception, preprocessing, station management, TMC-CA management.
FM Tx control	On request	On request	TBD	TBD	To be implemented

For Traffic Message Channel (TMC) over FM RDS, GNS offers the proven best-in-class API solution, for easy TMC implementation.

15 DIGITAL AUDIO

15.1 Audio options

TC6000 offers different digital audio interface options to support digital audio I/O for FM and Bluetooth

1. Bluetooth and FM may share the same pins for digital audio . Only a single interface is needed to support audio functionalities. *See Bluetooth/FM AudioBus Sharing* for details. The shared audio interface will support Bluetooth Voice (over SCO connection) in conjunction with the HandsFree (HF) or HeadSet (HS) profiles.

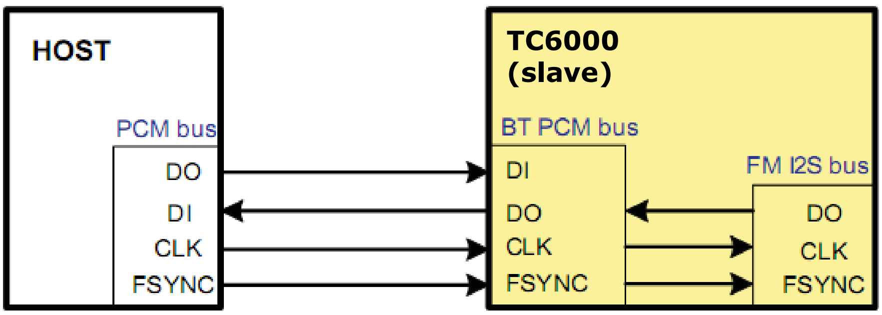
2. For stereo audio A2DP , the UART HCI interface must be used.

3. TC6000 can act as the "master" by supporting the CLK and framing signals or it can serve as the slave. When TC6000 is configured as the slave, the host must provide CLK and fsync signals.

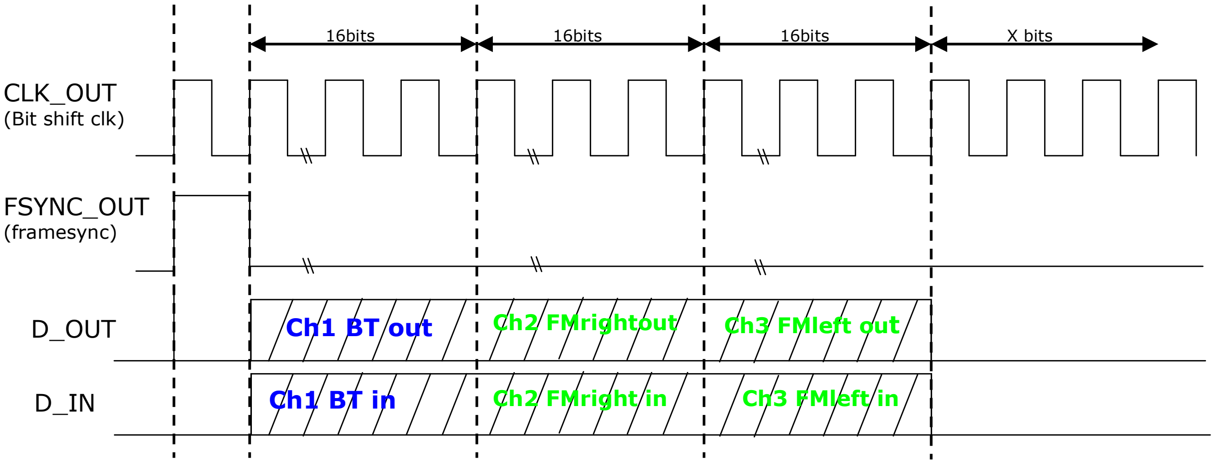
The options will be selected via registry configuration entries.

15.2 Bluetooth/FM Audio Bus Sharing for voice applications (HF & HS profiles)

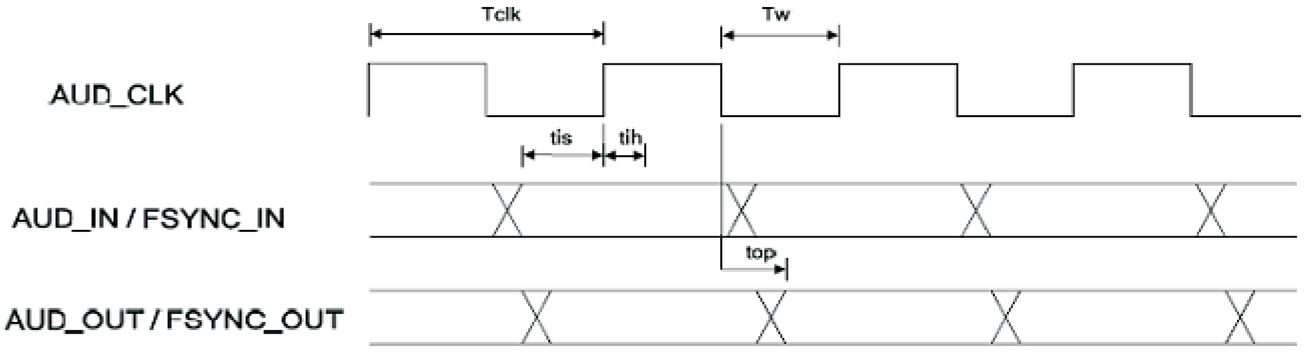
The FM I2S bus is connected to the BT PCM bus internally to achieve BT/FM audio bus sharing. To do this, the FM I2S signals change to PCM protocol to achieve the configuration.
The FM I2S and BT PCM pins will be connected internally with the help of a software command.
In the shown configuration, the TC6000 has been configured to provide the CLK and fsync signals.



A time multiplexing scheme must be used to allow the different audio signals to share the same pins. Please be sure your host system will follow this time diagram:



15.3 PCM and I2S Timings

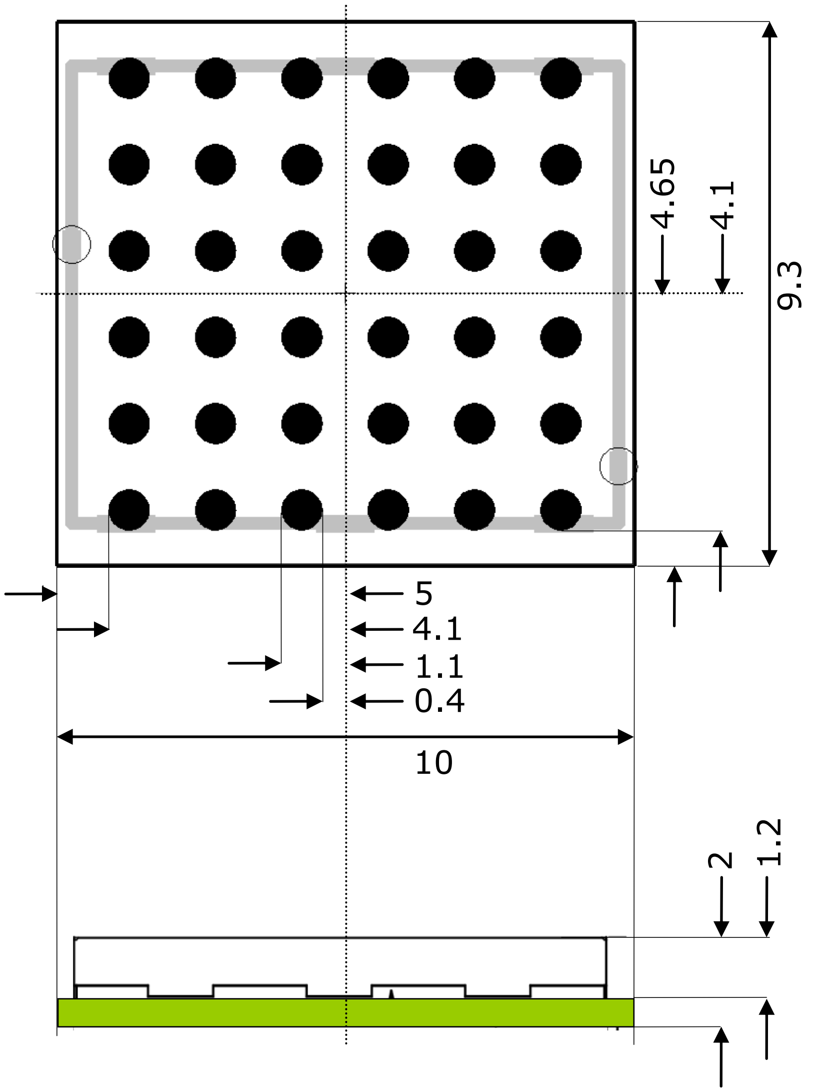


TC6000 as PCM Master						
Parameter		Min	Typ	Max	Unit	Note
t_{clk}	Cycle time	244		15625	ns	
freq	Frequency (1/ Cycle time)	64		4098	kHz	
t_{is}	AUD_IN setup time	30			ns	
t_{ih}	AUD_IN hold time	10			ns	
t_{op}	AUD_OUT / FSYNC_OUT propagation time			10	ns	50pF load

TC6000 as PCM Slave						
Parameter		Min	Typ	Max	Unit	Note
t_{clk}	Cycle time	61		15625	ns	
freq	Frequency (1/ Cycle time)	64		16393	kHz	
t_{is}	AUD_IN setup time	5			ns	
t_{ih}	AUD_IN hold time	8			ns	
t_{op}	AUD_OUT / FSYNC_OUT propagation time			20	ns	50pF load

16 PHYSICAL DIMENSIONS

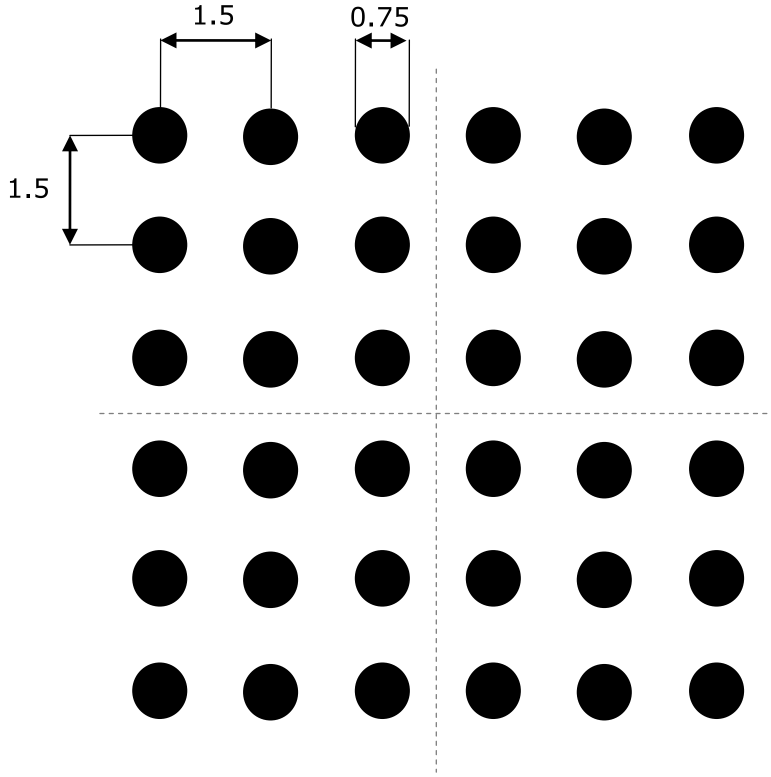
TOP VIEW



all units in mm

17 RECOMMENDED PAD LAYOUT

TOP VIEW



all units in mm

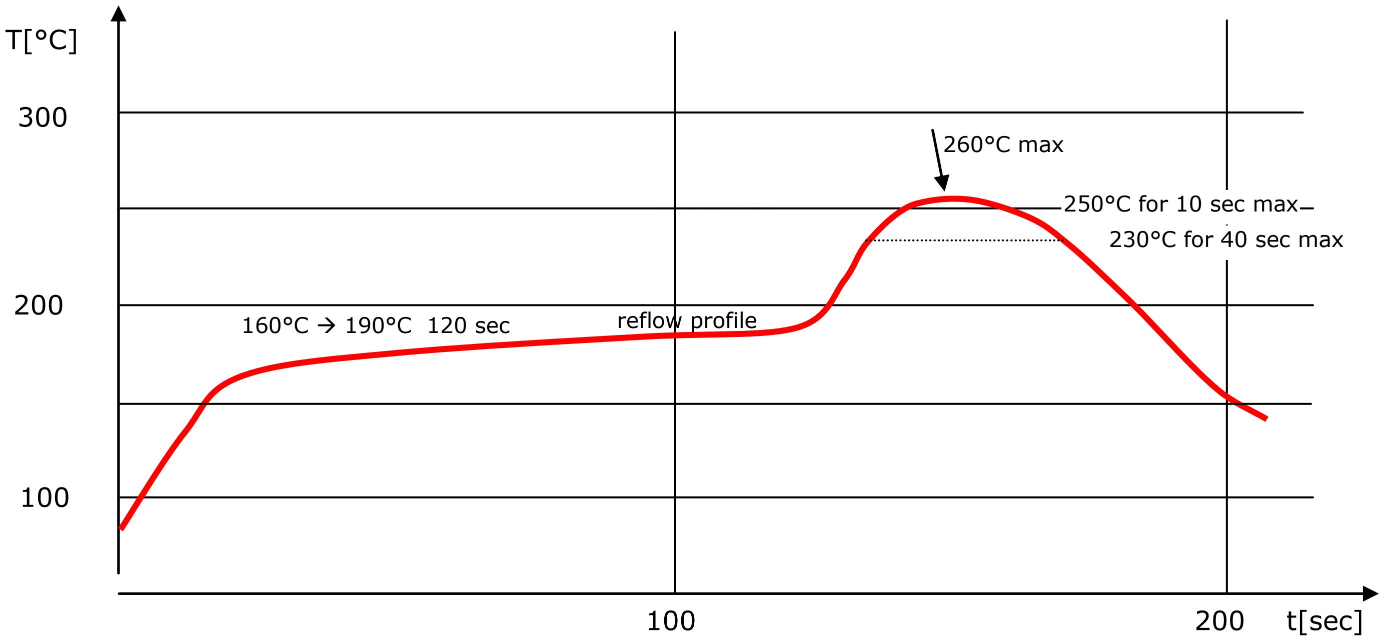
18 MATERIAL INFORMATION

complies to ROHS standard
ROHS documentations are available on request
contact surface : gold over nickel

18.1.1 Shield Material Information

"German Silver " , CuNi18Zn27
Cu: 53.5..56.5%
Ni : 16.5..19.5%
Zn : 24..30%
thickness :0.2mm

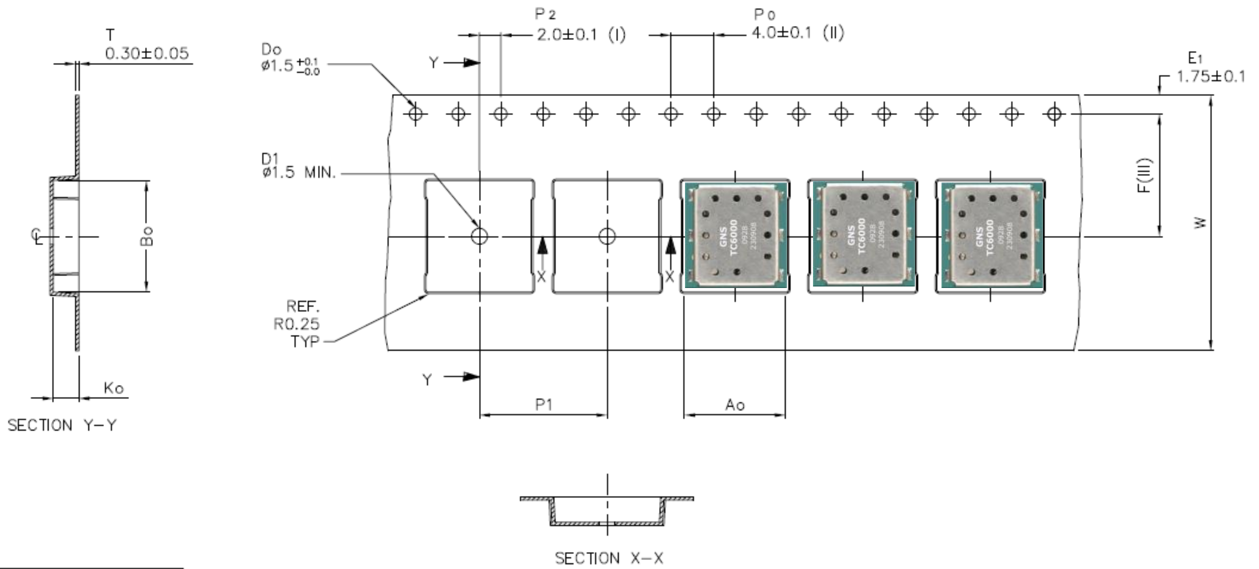
19 RECOMMENDED SOLDERING REFOLW & GLUE HARDENER PROFILE



Notes:

1. TC6000 should be soldered in upright soldering position. In case of head-over soldering, please prevent shielding / TC6000-Module from falling down.
2. Do never exceed maximum peak temperature
3. Reflow cycles allowed : 1 time
4. Do not solder with Pb-Sn or other solder containing lead (Pb)
5. This device is not applicable for flow solder processing
6. This device is not applicable for solder iron process !

20 TAPE INFORMATION



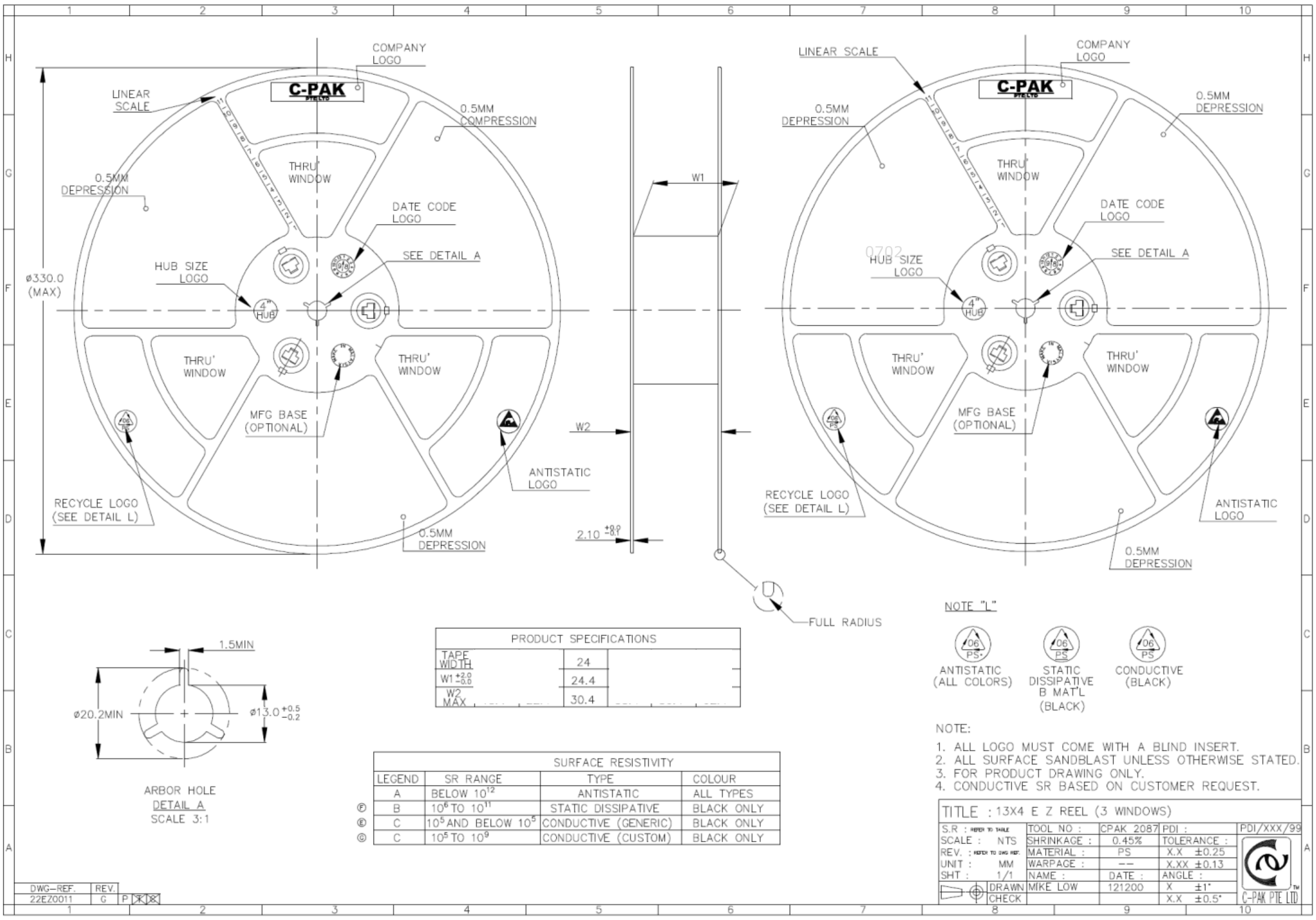
Ao	9.80	+/− 0.1
Bo	10.50	+/− 0.1
Ko	2.40	+/− 0.1
F	11.50	+/− 0.1
P1	12.00	+/− 0.1
W	24.00	+/− 0.3

Forming format : Flatbed
Estimated max. length : 60 meter/22B3 reel

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

21 REEL INFORMATION



no. of devices : 2000 pcs / reel

22 ORDERING INFORMATION

Ordering information			
Type	**Part#**	**Laser marking**	**Description**
TC6000	4037735104068	TC6000 GNS <yy mm> <serial#>	GPS-/FM-/BT-Module with embedded TCXO

23 ENVIRONMENTAL INFORMATION

This product is free of environmental hazardous substances and complies to 2002/95/EC. (RoHS directive).

RoHS
COMPLIANT
2002/95/EC

24 MOISTURE SENSITIVITY

Shelf life	Unlimited
Storage conditions	≤30C/85%RH
Moisture Sensitivity Level (MSL)	1
Possible prebake recommendations	None

25 DOCUMENT REVISION HISTORY

V0.01	Sep 04 2009	K.Rudnizki	initial objective
V0.03	Feb 04 2010	K.Rudnizki	
V0.04	Feb 26 2010	K.Rudnizki	
V0.05	Mar 04 2010	K.Rudnizki	Uart Timing, PCM Timing, FM Audio Paths
V0.1	Jun 11 2010	P.Skaliks	Overall revision, doc status changed to preliminary V01
V0.11	Jun 15 2010	P.Skaliks	Added MSL information
V0.12	July 16 2010	M.Reiff	Added Host Interface Combinations
V0.13	Aug 10 2010	P.Skaliks	Added host protocol, formal rework of doc
V0.14	Sep 28 2010	P.Skaliks	Added information digital audio
V0.15	Dec 15 2010	P.Skaliks	Added information, extended maximum ratings (temp),BT standard extended to 3.0+EDR,pps data added, packaging, solder profile, GPS description, BT description
V0.16			Corr. TCXO_CLK pin
V0.17	June 08 2012	M.Reiff	Related documents, GPS accuracy and ITAR limits added; chpt3.1 GPS sensitivity, GPS deep sleep current and laser marking corrected;

26 RELATED DOCUMENTS

Type	description	Ref	Available from
TC6000_StarterKit_User manual	Hardware manual for the GNS TC6000 Starter Kit	1	www.forum.gns-gmbh.com
GPS Antenna Connection Design Guide	Design Guide to implement an GPS antenna to an application PCB	2	www.forum.gns-gmbh.com
TC6000GN StarterKit_TestGuide	A guide for testing TC6000series against other GPS receivers	3	www.forum.gns-gmbh.com

27 PACKAGING

1 reel		
contents	2,000pcs	
GNS part#	2 x 6550000003 1x 6550000011	
dimensions	dia: 330mm thickness:30.4mm	
gross weight	1.195 Kg	with full contents
net weight	0.246 Kg	
2 vacuum bag		
GNS part#	6550000006	
dimensions	400mm x 480mm	
gross weight	1.263 kg	with full contents
net weight	0.068 Kg	
air pressure level	<30mbar	
3 moisture indicator		
GNS part#	6550000008	
dimensions	76mm x 51mm	
weight	0.001 Kg	
4 dry pack		
GNS part#	6550000007	
dimensions	145mm x 140mm	
weight	0.068 Kg	
5 Box for reel		
GNS part#	6550000012	
dimensions	350 mm x 350mm x 47mm	
gross weight	1.516 kg	with full contents
net weight	0.184 kg	
6 Outer box		
contents	max 7 box for reel	(14,000 pcs TC6000)
dimensions	400mm x 370mm x 360mm	
gross weight	10.612 kg	with full contents
net weight	0.85 kg	