User Manual

For CT301

15.08.2019

- when it has to be **right**

Leica Geosystems
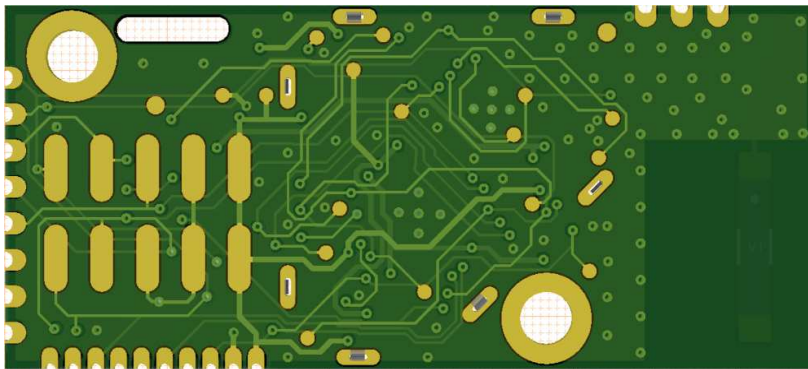
CONFIDENTIAL

Date / Editor	Version / Comment
08-03-2019 / 4081-BOG	Document creation
11-03-2019 / 4081-BOG	Update electrical interface, command table, filter table

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1 INTRODUCTION

Top
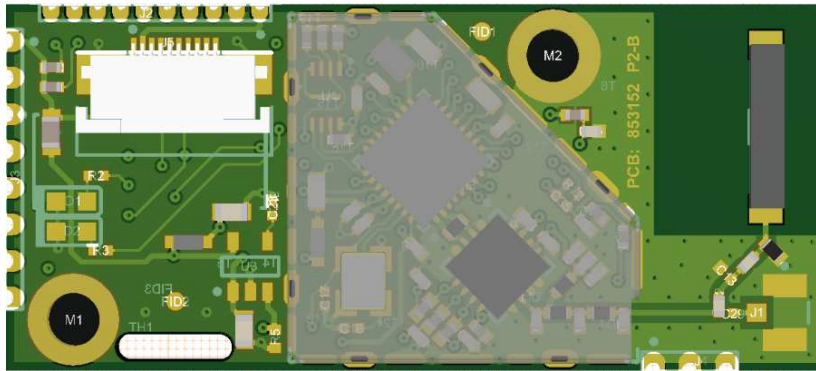
Bottom

The CT301 radio facilitates a IEEE 802.15.4 based radio communication. It uses a proprietary wireless communication stack to implement a star or cluster network with multiple nodes communicating simultaneously.

The radio module provides three basic functions:

- Transparent communication between network node and network coordinator
- Writing parameters to the radio module for configuration to determine its mode of operation such as the configuration of a node or coordinator
- Reading parameters from the radio module

All communication to the radio module is established through a UART communication interface.

2 ELECTRICAL INTERFACE

2.1 Maximum Ratings

| Rating	Min.	Max.	Unit
Input Voltage VCC	-0.3	3.6	V
Input Current VCC		150	mA
Operating Temperature	-30	60	°C

2.2 Operating Conditions

Rating	Min.	Typ	Max.	Unit
Input Voltage VCC	3.0	3.15	3.3	V
Operating Current RX mode (across temperature and supply voltage range)	15	20.3	30	mA
Operating Current TX with CW 18dBm	93	130	175	mA
Operating Current TX with CW 10dBm	46	70	94	mA
Sleep mode current	10	15	25	µA
RF Output Power E.I.R.P USA		18		dBm
RF Output Power E.I.R.P Europa		10		dBm

2.3 Connector

The radio module is connected through a 10-pin 0.5mm pitch flat cable on connector J5:

Main function	I/O	10-Pin	Description	Comment
VCC		1	Power Supply 3 / 3.3 V	
VCC		2	Power Supply 3 / 3.3 V	
GND		3	Ground	
GND		4	Ground	
GND		5	Ground	
UART TX	O/O	6	UART TX (Out)	High impedance if in shutdown.
UART RX	I/I	7	UART RX (In)l	High impedance if in shutdown.
RTS	O/I	8	Not used	Option SW implemented, wired to corresponding hardware pin on µC. High impedance if in shutdown.
CTS	I/I	9	Not Used	Option SW implemented, wired to corresponding hardware pin on µC. High impedance if in shutdown
SHUTDOWN	I	10	Enable sleep mode	Shutdown or sleep mode, to be able to select multiple radio modules

The location of connectorJ5 is indicated below. To provide cable relief a slot is integrated into the radio module.

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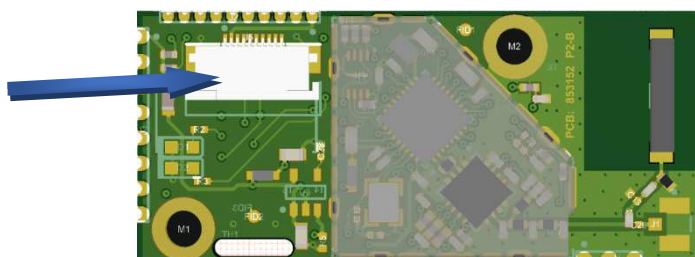
3 UART CONFIGURATION

Baudrate	Data Bits	Stop bits	Parity	Flow Control
19200	8	1	No	No

4 MODULE MOUNTING

The CT301 radio module can be mounted with two 2.5mm machine screws. It is preferred that the screws and stand offs are made of non conductive and non-ferromagnetic material such as plastic or ceramics.

Alternatively the module can be directly soldered on to a carrier board utilizing the radio module using connector J3 and J5.

5 RADIO MODULE COMMAND SET

The following table lists all commands available to the user through the UART communication.

Ref	Command	Response	Remark
31	`LF or CR/LF`	`0/READY`	*May be used to wake up from sleep mode.*
40	`------`	`0/UNKNOWN`	*Unknown command for device 0.*
41	`------`	`0/MISSING`	*This command is missing or not implemented*
45	`n/_____`	`nothing`	*Normal addressing can be used to send data to a Chameleon device. 1 - 63 data bytes may be appended. N is the address of the Filter n paired to the other device. The address n is 1 hex digit.* *The address n=0 is the own address of the device*
46	`nnnn/_____`	`nothing`	*Extended addressing can be used to send data to a specific WPS address. The address specifier has to consist of 4 hex digits.*
		TEST commands	
1	`0/TEST/CW/hh`	`0/OK` `0/ERR`	*Generate CW Signal for Test with TX power of 0-n dBm. Test function for EMV measurement.*
2	`0/TEST/RND/hh`	`0/OK` `0/ERR`	*Generate random Signal for Test with TX power of hh dBm. Test function for EMV measurement.*
3	`0/TEST/DUTY/hh`	`0/OK` `0/ERR`	*Set 'ON' time in ms for test signal. Total duty cycle period is 100ms. Minimum is 10 (0A). Maximum is 100 (64).*
4	`0/TEST/CH/hh`	`0/OK` `0/ERR`	*Force module to channel 0xhh. Can be used during regular operation (however in that case the WPS stack may change it at any time).*
5	`0/TEST/LOOP`	`0/OK`	*Enable / disable UART Loop back. All commands are still processed.*
6	`0/TEST/END`	`0/OK` `0/ERR`	*Finish any test mode. An error is generated if no test signal is active.*

7	0/TEST/HIST/OK	0/OK	*Assertion history is always empty.* *Not supported anymore.*
8	0/TEST/VER	0/VER/hhhhhhhh/ hhhhhhhh	*Get version number of SW and WPS (High word/Low word).*
9	0/TEST/BUILD	Not defined	*For debug purposes. Returns build and revision information.*
10	0/TEST/INFO	Not defined	*For debug purposes (may scan all selected channels and return dBm)*
11	0/TEST/RX	0/RX/hh	*Get current RX level hh dBm. Works only if no TX test mode is active.*
68	0/TEST/RESET	0/BOOTING 0/READY	*Reboot the system.*
74	0/TEST/TXIP/hhhh	0/OK 0/TXIP/hhhh	*Set the TX power direct (msbs: 0-5 IB25, 6-7 PA, 8-15 tempCoeff (IB = IB25 + (T -25) *TempCoeff / 512).To bring the system back to regular mode, the value must be set to 0 or the Radio device must be restarted.*
75	0/TEST/TXIP	0/TXIP/hhhh	*Get the direct TX power setting.*
		Status commands	
13	0/STAT/RX/n	0/RX/n/hh	*Get receive strength in dBm of last LiveLine frame from device n, so do enable LL mechanism*
14	0/STAT/PER/n	0/PER/hhhhhhhh	*Get Packet error rate of connection to device n (incremented on WPS_NO_LINK events only)*
15	0/STAT/RPER	0/OK	*Reset all Packet error rate counters*
16	0/STAT/INFO	0/INFO/hhhhhhhh	*Get radio module info (power)* *0x0000000**0** = maximum possible tx power in dBm.* *0x0000**00**00 = minimum possible tx power in dBm*
17	0/STAT/CH	0/CH/hh	*Get current channel.*
18	0/STAT/SLEEP	0/SLEEP	*Radio module is forced to sleep as soon as the WPS is idle.*
		Configuration commands	
19	0/CONF/FTR/n/hhhhhhhh	0/OK 0/ERR	*Set filter value 0xhhhhhhhh for filter /* *address n. Also used to configure the role radio module itself (with n = 0).* *For n=0 the filter could not set to 00000000*
20	0/CONF/FTR/n	0/FTR/n/hhhhhhhh	*Get filter value*
21	0/CONF/TXP/hh	0/OK 0/ERR	*Set power-limit in dBm. Value out of possible range will be truncated into the range.* *Range for CT301 (0x00 – 0x16) dBm.*
22	0/CONF/TXP	0/TXP/hh	*Get. Max Power in dBm (may be truncated)*
23	0/CONF/DEV/n	0/DEV/n/none 0/DEV/n/hhhh	*Get WPS address of device that is paired on filter structure n.* *FFFF means no configuration*
24	0/CONF/CH/hhhh	0/OK	*Set allowed channel with bitmask hhhh. LSB = channel*

		0/ERR	11. MSB = channel 26. On a laser it triggers the search for the quietest channel.
25	0/CONF/CH	0/CH/hhhh	Get allowed channel bitmask.
26	0/CONF/LL/n	0/OK 0/ERR	Set Live Line target to filter n. Setting is stored in Flash.
27	0/CONF/RSTLL	0/OK 0/ERR	Reset any set LL target. Setting is stored in Flash.
28	0/CONF/BAUD/x	0/OK 0/ERR	Sets the baud rate. Value is hex. The baud rate is changed immediately after the response 0/OK is sent. Both communication partners shall make a 2.5ms pause after 0/OK was transmitted to give the partner time to reconfigure.
29	0/CONF/TIMLL/hh	0/OK 0/ERR	Set Live Line repetition time, value is in hex, with 10ms resolution.
30	0/CONF/GAIN/h	0/OK 0/ERR	Set the LNA gain of the PA on the 300m Radio h=0: low gain; h=1: high gain
69	0/CONF/PANID	0/PANID/hhhh	Get the random PanId. Not Implemented.
73	0/CONF/REFORMAT	0/BOOTING 0/READY	Initialize the nonvolatile data and restart.
		Pairing commands	
32	0/PAIR/START	0/OK 0/ERR	Start pairing with new network (only for Remote / Receiver).
33	0/PAIR/ALLOW	0/OK 0/ERR	Allow pairing of new device (only for coordinator/Laser).
34	0/PAIR/STOP	0/OK 0/ERR	Stop pairing for new devices (only for coordinator/Laser).
47	0/PAIR/NETLIST	0/OK 0/ERR	Discover all lasers/coordinators by PAN ID. Only the lasers supporting this feature are answering to it. The list may contain max. 32 devices, sorted by signal strength (strongest first) and can be read by 0/PAIR/ELEMENT command. The command needs always the same time to check all channels (the request is repeated a few times on each channel). Command does not unpair the current connection, but the live line transmission shall be disabled before calling NETLIST.
72	0/PAIR/ELEMENT	0/ELEMENT/id,s 0/ERR	Reads one entry at a time from discovery list (generated by 0/PAIR/NETLIST command). The id is the 16bit PAN ID of the laser. s is the signal strength. When all devices were read the response is 0/ERR. Same if no devices were found. The list can be read only once.

48	`0/PAIR/SELECT/id/hhhh` `0/PAIR/SELECT/id` `0/PAIR/UNSELECT`	`0/OK` `0/ERR`	*Selects a laser. The id is the PAN ID of the laser. OK is only a immediate acknowledge. hhhh is a optional user value transmitted to laser. Command also enables the visual feedback on laser (by a periodic request every 0.5s). For keeping visual feedback the sleep of the node must be prevented by a "\n" or by repeating the command. The visual feedback is disabled on: sleep, any other command from host, UNSELECT command.* *Command does not unpair the current connection, but the live line transmission shall be disabled before.*
49	`0/PAIR/CONFIRM`	`0/OK` `0/ERR`	*Start pairing sequence with laser device, previously selected by SELECT command. It is stored to NV memory (exactly the same as regular pairing). The previous connection is lost. On successful pairing the message 0/PAIR/n is shown on coordinator/laser.*
73	`0/PAIR/ID`	`0/ID/id` `0/ERR`	*Returns the 16bit PAN ID of the paired device (paired by 0/PAIR/START or 0/PAIR/CONFIRM). 0/ERR if not paired.*
		Asynchrony commands	
35		`0/LOST/n`	*Live line connection lost with device, that is paired to filter n.*
36		`0/FOUND/n`	*Live line connection reestablished with device, that is paired to filter n.*
37		`0/CHSWITCH/hh`	*Radio switched to new channel (only in debug mode)*
38		`0/OK`	*Send data successful.*
39		`0/FAIL/n`	*Send data failed.*
42		`0/PAIR/n`	*Paired new Device to filter n.*
71		`0/NETLIST_ACK`	*Asynchronous response after 0/PAIR/NETLIST command, which always needs the same time to complete the search (ca. 200ms default).*
70		`0/SELECTED/hhhh` `0/UNSELECTED`	*request for (visual) feedback on coordinator. hhhh is a user value from application of node. Laser application does not need a timeout for selection: a 0/UNSELECTED will always come after a timeout.*
70		`0/SELECT_ACK` `0/SELECT_LOST`	*messages on node/combo during (visual) feedback. An initial SELECT_ACK is sent on the first acknowledge from coordinator/laser. SELECT_LOST is sent if the coordinator does not acknowledge anymore (to the periodic request from node). And ACK again if the coordinator is responding again.*
43		`0/READY`	*The radio module is ready to receive data via UART or transceiver after sleep mode or power-up.*
44		`0/WPS/hhhh` `0/WPS/hhhhhhhh`	*The WPS crashed. This event occurs twice. The first error gives the file number and the second gives the line nr that caused the crash.*

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6   RADIO MODULE CONFIGURATION

The radio module can be configured through filters using the command 0/CONF/FTR/n/hhhhhhhh, whereas n indicates the filter number and h the filter bit mask. Each filter corresponds to a node in the network where as filter 0 is reserved for the radio module configuration. Each bit in the mask has a dedicated function:

6.1   Filter Table

Type/ Bit range	Bitmask	Value	Remark
Manufacturer Type 31-24 (8 bit)	31	0/1	Leica Device
	30	0	Reserved
	29	0	Reserved
	28	0	Reserved
	27	0	Reserved
	26	0	Reserved
	25	0	Reserved
	24	0	Reserved
Device Type 23-16 (8 bit)		0x11	Laser
		0x12	Remote
		0x13	Receiver
		0x14	USB stick
		0x15	Remote (RC800)
		0x16	Combo Control
		0x17...0xFE	Reserved
		0xFF	All devices
Axis Type 15-14 (2 bit)	15	0/1	X-Axis
	14	0/1	Y-Axis
Range Type 13-11 (3 bit)	13	1	Reserved
	12	0/1	300m
	11	0/1	100m
Reserved 10-4 (7 bit)		0x7F	Reserved
Device Number 3-0 (4 bit)		0x0..0xE	Device Number
		0xF	All device number allowed

6.2 Examples

Configuration of Combo Control
`0/CONF/FTR/0/8016D00F<CR><LF>` // Leica Combo Control 300 /x/y all devices allowed
`0/CONF/FTR/1/8011D80F<CR><LF>` // Leica Laser filter 100 /300 /x/y all devices allowed

Configuration of Laser
`0/CONF/FTR/0/8011D80F<CR><LF>` // Leica Laser Device
`0/CONF/FTR/1/8016D00F<CR><LF>` // Leica Combo Control filter 300 /x/y
`0/CONF/FTR/2/8016D00F<CR><LF>` // Leica Combo Control filter 300 /x/y
`0/CONF/FTR/3/8016D00F<CR><LF>` // Leica Combo Control filter 300 /x/y

Pairing allowed on laser
`0/PAIR/ALLOW<LF>`

Pairing of Receiver
`0/PAIR/START<LF>`

Pairing of Remote
`0/PAIR/START<LF>`

Pairing Stop
`0/PAIR/Stop<LF>`

Send Data from Combo Control to Laser
`1/set/23/34<LF>`

Get all reachable devices
`0/NETLIST<LF>`
                                    `<- 0/NETLIST_ACK<LF>`
`0/PAIR/ELEMENT<LF>`
                                    `<- 0/ELEMENT/426A,64<LF>`
`0/PAIR/ELEMENT<LF>`
                                    `<- 0/ELEMENT/246E,54<LF>`
`0/PAIR/ELEMENT<LF>`
                                    `<- 0/ERR`   // no other devices

Pairing initiated by Combo device
`0/PAIR/SELECT/426a/1<LF>`   // PanId Laser=426a, 1 is the indication for the Laser to start pairing
                                    `<- 0/OK<LF>`
                                    `<- 0/SELECT_ACK<LF>`

`0/PAIR/CONFIRM<LF>`
                                    `<- 0/OK<LF>`

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7 CERTIFICATION

7.1 FCC Certification

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference that may cause undesired operation.

If using a permanently affixed label, the modular transmitter must be labeled with its own FCC identification number, and, if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: RFD-CT301" or "Contains FCC ID: RFD-CT301". Any similar wording that expresses the same meaning may be used. The Grantee may either provide such a label, an example of which must be included in the application for equipment authorization, or, must provide adequate instructions along with the module which explain this requirement. In the latter case, a copy of these instructions must be included in the application for equipment authorization.

Installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

7.2 Industry Canada Certification

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet équipement est conforme du réglement de la Industry Canada.
(1) l'appareil ne doit pas générer d'interférences nuisibles et (2) doit accepter toutes interférences y compris celles pouvant provoquer un fonctionnement indésirable.

The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning as follows:

Contains transmitter module IC: 3177A-CT301

7.1 Japan Certification

Japanese Radio Law and Japanese Telecommunications Business Law Compliance.

This device has been granted a designation number by Ministry of Internal Affairs and Communications under „Ordinance concerning Technical Regulations Conformity Certification etc. of Specified Radio Equipment (特定無線設備の技術基準適合証明等に関する規則)" Article 2-1-19.

"This device should not be modified (otherwise the granted designation number will be invalid)"

R:202-LSF027