



Digi XBee® LR LoRaWAN

RF Module

User Guide

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- Operating system/browser (if applicable)
- Logs (from time of reported issue)
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- Description of issue
- Steps to reproduce

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Digi XBee LR LoRaWAN RF Module Software Manual

This manual describes the operation of the XBee LR LoRaWAN RF Module.

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Applicable firmware and hardware

This user guide supports the following firmware:

- v.1.0
- v.1.1

It supports the following hardware:

- XBLR-RM-001
- XBLR-UM-001

Regulatory information

See the Regulatory information section of the *XBee LR Module Hardware Reference Manual* for the XBee LR hardware's regulatory and certification information.

Get started

Refer to the XBee LR Hardware User Guide for comprehensive instructions and examples on how to get started with the XBee LR LoRaWAN RF Module.

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Safety instructions

XBee modules

- The XBee radio module cannot be guaranteed operation due to the radio link and so should not be used for interlocks in safety critical devices such as machines or automotive applications.
- The XBee radio module has not been approved for use in (this list is not exhaustive):
 - medical devices
 - nuclear applications
 - explosive or flammable atmospheres
- There are no user serviceable components inside the XBee radio module. Do not remove the shield or modify the XBee in any way. Modifications may exclude the module from any warranty and can cause the XBee radio to operate outside of regulatory compliance for a given country, leading to the possible illegal operation of the radio.
- Use industry standard ESD protection when handling the XBee module.
- Take care while handling to avoid electrical damage to the PCB and components.
- Do not expose XBee radio modules to water or moisture.
- Use this product with the antennas specified in the XBee module user guides.
- The end user must be told how to remove power from the XBee radio module or to locate the antennas cm from humans or animals.

Инструкции за безопасност

XBee модули

- Радио модулът XBee не може да бъде гарантиран за работа поради радиовръзката и затова не трябва да се използва за блокировки в критични за безопасността устройства като машини или автомобилни приложения.
- Радио модулът XBee не е одобрен за използване в (този списък не е изчерпателен):
 - медицински изделия
 - ядрени приложения
 - експлозивна или запалима атмосфера
- В радиомодула XBee няма компоненти, които могат да се обслужват от потребителя. Не премахвайте щита и не модифицирайте XBee по никакъв начин. Модификациите могат да изключат модула от всякаква гаранция и да накарат радиото XBee да работи извън регулаторното съответствие за дадена държава, което води до възможна незаконна работа на радиото.
- Използвайте стандартна ESD защита при работа с XBee модула.
- Внимавайте, докато боравите, за да избегнете електрически повреди на печатната платка и компонентите.
- Не излагайте радиомодулите XBee на вода или влага.

- Използвайте този продукт с антените, посочени в ръководствата за потребителя на модула XBee.
- Крайният потребител трябва да бъде казано как да премахне захранването от радиомодула XBee или да разположи антените на 20 см от хора или животни.

Sigurnosne upute

XBee moduli

- Radio modulu XBee ne može se jamčiti rad zbog radio veze i stoga se ne smije koristiti za blokade u sigurnosnim kritičnim uređajima kao što su strojevi ili automobilske aplikacije.
- XBee radio modul nije odobren za upotrebu u (ovaj popis nije konačan):
 - medicinskih uređaja
 - nuklearne primjene
 - eksplozivne ili zapaljive atmosfere
- Unutar XBee radio modula nema komponenti koje može servisirati korisnik. Nemojte uklanjati štit i ni na koji način modificirati XBee. Izmjene mogu isključiti modul iz bilo kakvog jamstva i mogu uzrokovati rad XBee radija izvan usklađenosti s propisima za određenu zemlju, što može dovesti do mogućeg nezakonitog rada radija.
- Koristite standardnu ESD zaštitu pri rukovanju XBee modulom.
- Budite oprezni tijekom rukovanja kako biste izbjegli električna oštećenja PCB-a i komponenti.
- Ne izlažite XBee radio module vodi ili vlazi.
- Koristite ovaj proizvod s antenama navedenim u korisničkim vodičima za XBee modul.
- Krajnjem korisniku se mora reći kako da isključi napajanje iz XBee radio modula ili da locira antene 20 cm od ljudi ili životinja.

Bezpečnostní instrukce

moduly XBee

- Rádiový modul XBee nemůže zaručit provoz kvůli rádiovému spojení, a proto by neměl být používán pro blokování v zařízeních kritických z hlediska bezpečnosti, jako jsou stroje nebo automobilové aplikace.
- Rádiový modul XBee nebyl schválen pro použití v (tento seznam není vyčerpávající):
 - zdravotnické prostředky
 - jaderné aplikace
 - výbušné nebo hořlavé atmosféry
- Uvnitř rádiového modulu XBee nejsou žádné uživatelsky opravitelné součásti. Neodstraňujte štít ani nijak neupravujte XBee. Úpravy mohou vyjmout modul z jakékoli záruky a mohou způsobit, že rádio XBee bude fungovat mimo zákonnou shodu pro danou zemi, což povede k možnému nezákonnému provozu rádia.

- Při manipulaci s modulem XBee používejte standardní ochranu ESD.
- Při manipulaci buďte opatrní, aby nedošlo k elektrickému poškození desky plošných spojů a součástí.
- Nevystavujte rádiové moduly XBee vodě nebo vlhkosti.
- Používejte tento produkt s anténami uvedenými v uživatelských příručkách modulu XBee.
- Koncový uživatel musí být informován, jak odpojit napájení rádiového modulu XBee nebo jak umístit antény 20 cm od lidí nebo zvířat.

Sikkerhedsinstruktioner

XBee moduler

- XBee-radiomodul kan ikke garanteres drift på grund af radioforbindelsen og bør derfor ikke bruges til aflåsninger i sikkerhedskritiske enheder såsom maskiner eller bilapplikationer.
- XBee-radiomodul er ikke godkendt til brug i (denne liste er ikke udtømmende):
 - medicinsk udstyr
 - nukleare applikationer
 - eksplosive eller brandfarlige atmosfærer
- Der er ingen komponenter, der kan repareres af brugeren, inde i XBee-radiomodul. Fjern ikke skjoldet eller modificer XBee på nogen måde. Ændringer kan udelukke modul fra enhver garanti og kan få XBee-radioen til at fungere uden for lovgivningsoverholdelse for et givet land, hvilket kan føre til den mulige ulovlige drift af radioen.
- Brug industristandard ESD-beskyttelse, når du håndterer XBee-modul.
- Vær forsigtig under håndteringen for at undgå elektrisk beskadigelse af printet og komponenterne.
- Udsæt ikke XBee-radiomoduler for vand eller fugt.
- Brug dette produkt med de antenner, der er specificeret i XBee-modulets brugervejledninger.
- Slutbrugeren skal fortælles, hvordan man fjerner strømmen fra XBee-radiomodul eller placerer antennerne 20 cm fra mennesker eller dyr.

Veiligheidsinstructies

XBee-modules

- De werking van de XBee-radiomodule kan niet worden gegarandeerd vanwege de radioverbinding en mag daarom niet worden gebruikt voor vergrendelingen in veiligheidskritieke apparaten zoals machines of autotoepassingen.
- De XBee-radiomodule is niet goedgekeurd voor gebruik in (deze lijst is niet uitputtend):

- o medische apparaten
 - o nucleaire toepassingen
 - o explosieve of ontvlambare atmosferen
- Er zijn geen door de gebruiker te onderhouden componenten in de XBee-radiomodule. Verwijder het schild niet en wijzig de XBee op geen enkele manier. Modificaties kunnen de module uitsluiten van enige garantie en kunnen ertoe leiden dat de XBee-radio werkt buiten de regelgeving voor een bepaald land, wat kan leiden tot de mogelijke illegale werking van de radio.
 - Gebruik industriestandaard ESD-bescherming bij het hanteren van de XBee-module.
 - Wees voorzichtig bij het hanteren om elektrische schade aan de printplaat en componenten te voorkomen.
 - Stel XBee-radiomodules niet bloot aan water of vocht.
 - Gebruik dit product met de antennes die zijn gespecificeerd in de gebruikershandleidingen van de XBee-module.
 - De eindgebruiker moet worden verteld hoe de voeding van de XBee-radiomodule moet worden losgekoppeld of hoe de antennes op 20 cm van mensen of dieren moeten worden geplaatst.

Ohutusjuhised

XBee moodulid

- XBee raadiomooduli tööd ei saa raadiolingi tõttu garanteerida ja seetõttu ei tohiks seda kasutada ohutuse seisukohalt oluliste seadmete (nt masinad või autorakendused) blokeerimiseks.
- XBee raadiomoodulit ei ole heaks kiidetud kasutamiseks (see loetelu ei ole ammendav):
 - meditsiiniseadmed
 - tuumarakendused
 - plahvatusohtlik või tuleohtlik keskkond
- XBee raadiomoodulis ei ole kasutaja poolt hooldatavaid komponente. Ärge eemaldage kaitset ega muutke XBee mingil viisil. Muudatused võivad mooduli garantiist välja jätta ja XBee raadio töötab väljaspool antud riigi regulatiivseid vastavusi, põhjustades radio võimaliku ebaseadusliku kasutamise.
- Kasutage XBee mooduli käsitsemisel tööstusharu standardset ESD-kaitset.
- Olge käsitsemisel ettevaatlik, et vältida PCB ja komponentide elektrikahjustusi.
- Ärge jätke XBee raadiomoduleid vee või niiskuse kätte.
- Kasutage seda toodet XBee mooduli kasutusjuhendis kirjeldatud antennidega.
- Lõppkasutajale tuleb öelda, kuidas XBee raadiomoodulilt toide eemaldada või antennid inimestest või loomadest 20 cm kaugusele paigutada.

Turvallisuusohjeet

XBee moduulit

- XBee-radiomoduulin toimintaa ei voida taata radiolinkin vuoksi, joten sitä ei tule käyttää turvallisuuden kannalta kriittisten laitteiden, kuten koneiden tai autosovellusten, lukitsemiseen.
- XBee-radiomoduulia ei ole hyväksytty käytettäväksi (tämä luettelo ei ole tyhjentävä):
 - lääketieteelliset laitteet
 - ydinvoimasovellukset
 - räjähdysvaarallisiin tai syttyviin tiloihin
- XBee-radiomoduulin sisällä ei ole käyttäjän huollettavia osia. Älä poista suojusta tai muokkaa XBeetä millään tavalla. Muutokset voivat sulkea moduulin takuun ulkopuolelle ja aiheuttaa sen, että XBee-radio toimii tietyn maan säädöstenmukaisuuden ulkopuolella, mikä johtaa radion mahdolliseen laittomaan käyttöön.
- Käytä alan standardia ESD-suojauksista käsitellessäsi XBee-moduulia.
- Ole varovainen käsitellessäsi, jotta vältät piirilevyn ja komponenttien sähkövauriot.
- Älä altista XBee-radiomoduuleja vedelle tai kosteudelle.
- Käytä tätä tuotetta XBee-moduulin käyttöoppaissa määriteltyjen antennien kanssa.
- Loppukäyttäjälle on kerrottava, kuinka XBee-radiomoduulin virta katkaistaan tai antennit sijoitetaan 20 cm:n etäisyydelle ihmisistä tai eläimistä.

Consignes de sécurité

Modules XBee

- Le fonctionnement du module radio XBee ne peut pas être garanti en raison de la liaison radio et ne doit donc pas être utilisé pour les verrouillages dans des dispositifs critiques pour la sécurité tels que des machines ou des applications automobiles.
- Le module radio XBee n'a pas été approuvé pour une utilisation dans (cette liste n'est pas exhaustive) :
 - dispositifs médicaux
 - applications nucléaires
 - atmosphères explosives ou inflammables
- Il n'y a aucun composant réparable par l'utilisateur à l'intérieur du module radio XBee. Ne retirez pas la protection et ne modifiez en aucune façon le XBee. Les modifications peuvent exclure le module de toute garantie et peuvent entraîner le fonctionnement de la radio XBee en dehors de la conformité réglementaire pour un pays donné, ce qui peut entraîner un fonctionnement illégal de la radio.
- Utilisez la protection ESD standard de l'industrie lors de la manipulation du module XBee.
- Soyez prudent lors de la manipulation afin d'éviter des dommages électriques au circuit imprimé et aux composants.

- N'exposez pas les modules radio XBee à l'eau ou à l'humidité.
- Utilisez ce produit avec les antennes spécifiées dans les guides d'utilisation du module XBee.
- L'utilisateur final doit savoir comment couper l'alimentation du module radio XBee ou placer les antennes à cm des humains ou des animaux.

Sicherheitshinweise

XBee-Module

- Der Betrieb des XBee-Funkmoduls kann aufgrund der Funkverbindung nicht garantiert werden und sollte daher nicht für Verriegelungen in sicherheitskritischen Geräten wie Maschinen oder Automobilanwendungen verwendet werden.
- Das XBee-Funkmodul ist nicht zugelassen für den Einsatz in (diese Liste ist nicht vollständig):
 - Medizinprodukte
 - nukleare Anwendungen
 - explosive oder brennbare Atmosphären
- Das XBee-Funkmodul enthält keine vom Benutzer zu wartenden Komponenten. Entfernen Sie nicht die Abschirmung oder modifizieren Sie das XBee in irgendeiner Weise. Modifikationen können das Modul von jeglicher Garantie ausschließen und dazu führen, dass das XBee-Funkgerät außerhalb der gesetzlichen Vorschriften für ein bestimmtes Land betrieben wird, was zu einem möglichen illegalen Betrieb des Funkgeräts führen kann.
- Verwenden Sie beim Umgang mit dem XBee-Modul ESD-Schutz nach Industriestandard.
- Seien Sie vorsichtig bei der Handhabung, um elektrische Schäden an der Leiterplatte und den Komponenten zu vermeiden.
- XBee-Funkmodule nicht Wasser oder Feuchtigkeit aussetzen.
- Verwenden Sie dieses Produkt mit den in den Benutzerhandbüchern des XBee-Moduls angegebenen Antennen.
- Dem Endbenutzer muss mitgeteilt werden, wie er das XBee-Funkmodul von der Stromversorgung trennt oder die Antennen 20 cm von Menschen oder Tieren entfernt aufstellt.

Οδηγίες ασφαλείας

Μονάδες XBee

- Η μονάδα ραδιοφώνου XBee δεν μπορεί να εγγυηθεί τη λειτουργία της λόγω της ραδιοζεύξης και επομένως δεν πρέπει να χρησιμοποιείται για ασφάλειες σε κρίσιμες για την ασφάλεια συσκευές, όπως μηχανήματα ή εφαρμογές αυτοκινήτου.
- Η μονάδα ραδιοφώνου XBee δεν έχει εγκριθεί για χρήση σε (αυτή η λίστα δεν είναι εξαντλητική):

- ιατροτεχνολογικά προϊόντα
 - πυρηνικές εφαρμογές
 - εκρηκτικές ή εύφλεκτες ατμόσφαιρες
- Δεν υπάρχουν εξαρτήματα που να μπορούν να επισκευαστούν από το χρήστη μέσα στη μονάδα ραδιοφώνου XBee. Μην αφαιρείτε την ασπίδα και μην τροποποιείτε το XBee με κανέναν τρόπο. Οι τροποποιήσεις ενδέχεται να αποκλείουν τη μονάδα από οποιαδήποτε εγγύηση και μπορεί να προκαλέσουν τη λειτουργία του ραδιοφώνου XBee εκτός της συμμόρφωσης με τους κανονισμούς για μια δεδομένη χώρα, οδηγώντας σε πιθανή παράνομη λειτουργία του ραδιοφώνου.
 - Χρησιμοποιήστε βιομηχανική προστασία ESD κατά το χειρισμό της μονάδας XBee.
 - Προσέχετε κατά το χειρισμό για να αποφύγετε ηλεκτρική βλάβη στο PCB και στα εξαρτήματα.
 - Μην εκθέτετε τις μονάδες ραδιοφώνου XBee σε νερό ή υγρασία.
 - Χρησιμοποιήστε αυτό το προϊόν με τις κεραίες που καθορίζονται στους οδηγούς χρήσης της μονάδας XBee.
 - Πρέπει να ενημερωθεί ο τελικός χρήστης πώς να αφαιρέσει την τροφοδοσία από τη μονάδα ραδιοφώνου XBee ή να εντοπίσει τις κεραίες σε απόσταση 20 cm από ανθρώπους ή ζώα.

Biztonsági utasítások

XBee modulok

- Az XBee rádiómodul működése nem garantálható a rádiókapcsolat miatt, ezért nem használható biztonsági szempontból kritikus eszközök, például gépek vagy autóiipari alkalmazások reteszelésére.
- Az XBee rádiómodul nem engedélyezett a következő területeken való használatra (ez a lista nem teljes):
 - orvosi eszközök
 - nukleáris alkalmazások
 - robbanásveszélyes vagy gyúlékony légkör
- Az XBee rádiómodulban nincsenek felhasználó által javítható alkatrészek. Ne távolítsa el a pajzsot, és semmilyen módon ne módosítsa az XBee-t. A módosítások kizárhatják a modult a jótállásból, és az XBee rádió működését az adott ország jogszabályi előírásaitól eltérően okozhatják, ami a rádió esetleges illegális működéséhez vezethet.
- Az XBee modul kezelésekor használjon ipari szabványos ESD védelmet.
- A kezelés során ügyeljen arra, hogy elkerülje a PCB és az alkatrészek elektromos károsodását.
- Ne tegye ki az XBee rádiómodulokat víznek vagy nedvességnek.
- Használja ezt a terméket az XBee modul használati útmutatójában meghatározott antennákkal.

- A végfelhasználót tájékoztatni kell arról, hogyan távolítsa el az XBee rádiómodul áramellátását, vagy hogyan helyezze el az antennákat az emberektől vagy állatoktól 20 cm-re.

Istruzioni di sicurezza

Moduli XBee

- Il funzionamento del modulo radio XBee non può essere garantito a causa del collegamento radio e quindi non deve essere utilizzato per gli interblocchi in dispositivi critici per la sicurezza come macchine o applicazioni automobilistiche.
- Il modulo radio XBee non è stato approvato per l'uso in (questo elenco non è esaustivo):
 - dispositivi medici
 - applicazioni nucleari
 - atmosfere esplosive o infiammabili
- Non ci sono componenti riparabili dall'utente all'interno del modulo radio XBee. Non rimuovere lo scudo o modificare in alcun modo l'XBee. Le modifiche possono escludere il modulo da qualsiasi garanzia e possono causare il funzionamento della radio XBee al di fuori della conformità normativa per un determinato paese, portando al possibile funzionamento illegale della radio.
- Utilizzare la protezione ESD standard del settore durante la manipolazione del modulo XBee.
- Prestare attenzione durante la manipolazione per evitare danni elettrici al PCB e ai componenti.
- Non esporre i moduli radio XBee all'acqua o all'umidità.
- Utilizzare questo prodotto con le antenne specificate nelle guide per l'utente del modulo XBee.
- L'utente finale deve sapere come togliere l'alimentazione al modulo radio XBee o come posizionare le antenne a 20 cm da persone o animali.

Drošības instrukcijas

XBee moduli

- Radio moduļa XBee darbība nevar tikt garantēta radio savienojuma dēļ, tāpēc to nevajadzētu izmantot bloķēšanai drošības ziņā kritiskās ierīcēs, piemēram, mašīnās vai automobiļos.
- XBee radio modulis nav apstiprināts lietošanai (šis saraksts nav pilnīgs):
 - medicīniskās ierīces
 - kodolprogrammas
 - sprādzienbīstamā vai uzliesmojošā vidē

- XBee radio moduļa iekšpusē nav neviena komponenta, ko lietotājs varētu apkopt. Nenoņemiet vairogu un nekādā veidā nepārveidojiet XBee. Modifikācijas rezultātā modulis var tikt izslēgts no jebkādas garantijas un var izraisīt XBee radio darbību, kas neatbilst noteiktās valsts normatīvajiem aktiem, izraisot iespējamu nelegālu radio darbību.
- Strādājot ar XBee moduli, izmantojiet nozares standarta ESD aizsardzību.
- Rīkojoties, rīkojieties uzmanīgi, lai izvairītos no PCB un komponentu elektriskiem bojājumiem.
- Nepakļaujiet XBee radio moduļus ūdens vai mitruma iedarbībai.
- Izmantojiet šo izstrādājumu ar antenām, kas norādītas XBee moduļa lietotāja rokasgrāmatās.
- Galalietotājam ir jāpaskaidro, kā atvienot XBee radio moduļa strāvu vai novietot antenas 20 cm attālumā no cilvēkiem vai dzīvniekiem.

Saugos instrukcijas

XBee moduliai

- Negalima garantuoti, kad „XBee“ radijo modulis veiks dėl radijo ryšio, todėl jo neturėtų būti naudojamas blokuoti saugai svarbiuose įrenginiuose, pvz., mašinos ar automobiliuose.
- XBee radijo modulis nebuvo patvirtintas naudoti (šis sąrašas nėra baigtinis):
 - medicinos prietaisai
 - branduolinės programos
 - sprogiuje ar degioje aplinkoje
- XBee radijo modulio viduje nėra komponentų, kuriuos vartotojas galėtų prižiūrėti. Jokių būdu nenuimkite skydo ir nekeiskite XBee. Dėl modifikacijų moduliui gali būti netaikoma jokia garantija, o „XBee“ radijas gali veikti ne pagal tam tikros šalies norminius reikalavimus, o tai gali sukelti neteisėtą radijo naudojimą.
- Dirbdami su XBee moduliui naudokite pramonės standartinę ESD apsaugą.
- Dirbdami būkite atsargūs, kad nepažeistumėte PCB ir komponentų.
- Saugokite XBee radijo modulių nuo vandens ar drėgmės.
- Naudokite šį gaminį su antenomis, nurodytomis XBee modulio vartotojo vadove.
- Galutiniam vartotojui turi būti paaiškinta, kaip atjungti XBee radijo modulio maitinimą arba nustatyti antenas 20 cm atstumu nuo žmonių ar gyvūnų.

Sikkerhetsinstruksjoner

XBee-moduler

- XBee-radiomodulen kan ikke garanteres drift på grunn av radiolinken, og bør derfor ikke brukes til forriglinger i sikkerhetskritiske enheter som maskiner eller bilapplikasjoner.
- XBee-radiomodulen er ikke godkjent for bruk i (denne listen er ikke uttømmende):

- medisinsk utstyr
 - kjernefysiske applikasjoner
 - eksplosive eller brennbare atmosfærer
- Det er ingen komponenter som kan repareres av brukeren inne i XBee-radiomodulen. Ikke fjern skjoldet eller modifier XBee på noen måte. Endringer kan ekskludere modulen fra enhver garanti og kan føre til at XBee-radioen fungerer utenfor regelverket for et gitt land, noe som kan føre til ulovlig drift av radioen.
 - Bruk industristandard ESD-beskyttelse når du håndterer XBee-modulen.
 - Vær forsiktig ved håndtering for å unngå elektrisk skade på PCB og komponenter.
 - Ikke utsett XBee radiomoduler for vann eller fuktighet.
 - Bruk dette produktet med antennene spesifisert i XBee-modulens brukerveiledninger.
 - Sluttbrukeren må bli fortalt hvordan man fjerner strømmen fra XBee-radiomodulen eller plasserer antennene 20 cm fra mennesker eller dyr.

Instrukcje bezpieczeństwa

Moduły XBee

- Moduł radiowy XBee nie może zagwarantować działania ze względu na łącze radiowe, dlatego nie należy go używać do blokad w urządzeniach o krytycznym znaczeniu dla bezpieczeństwa, takich jak maszyny lub aplikacje motoryzacyjne.
- Moduł radiowy XBee nie został dopuszczony do użytku w (lista ta nie jest wyczerpująca):
 - wyroby medyczne
 - zastosowania nuklearne
 - atmosferach wybuchowych lub łatwopalnych
- Wewnątrz modułu radiowego XBee nie ma żadnych elementów, które mogłyby być serwisowane przez użytkownika. Nie zdejmuj osłony ani nie modyfikuj XBee w żaden sposób. Modyfikacje mogą wykluczyć moduł z jakiegokolwiek gwarancji i spowodować, że radio XBee będzie działać niezgodnie z przepisami obowiązującymi w danym kraju, co może prowadzić do nielegalnego działania radia.
- Podczas obsługi modułu XBee należy stosować standardową ochronę ESD.
- Podczas obsługi należy zachować ostrożność, aby uniknąć uszkodzeń elektrycznych PCB i komponentów.
- Nie wystawiaj modułów radiowych XBee na działanie wody lub wilgoci.
- Używaj tego produktu z antenami określonymi w podręcznikach użytkownika modułu XBee.
- Użytkownik końcowy musi zostać poinformowany, jak odłączyć zasilanie modułu radiowego XBee lub zlokalizować anteny w odległości 20 cm od ludzi lub zwierząt.

Instruções de segurança

Módulos XBee

- O módulo de rádio XBee não pode ter operação garantida devido ao link de rádio e, portanto, não deve ser usado para intertravamentos em dispositivos críticos de segurança, como máquinas ou aplicações automotivas.
- O módulo de rádio XBee não foi aprovado para uso em (esta lista não é exaustiva):
 - o dispositivos médicos
 - o aplicações nucleares
 - o atmosferas explosivas ou inflamáveis
- Não há componentes que possam ser reparados pelo usuário dentro do módulo de rádio XBee. Não remova a blindagem nem modifique o XBee de forma alguma. As modificações podem excluir o módulo de qualquer garantia e fazer com que o rádio XBee opere fora da conformidade regulatória de um determinado país, levando à possível operação ilegal do rádio.
- Use proteção ESD padrão da indústria ao manusear o módulo XBee.
- Tome cuidado ao manusear para evitar danos elétricos à PCB e aos componentes.
- Não exponha os módulos de rádio XBee à água ou umidade.
- Use este produto com as antenas especificadas nos guias do usuário do módulo XBee.
- O usuário final deve ser informado sobre como remover a energia do módulo de rádio XBee ou localizar as antenas a 20 cm de humanos ou animais.

Instructiuni de siguranta

module XBee

- Nu se poate garanta funcționarea modulului radio XBee din cauza conexiunii radio și, prin urmare, nu trebuie utilizat pentru interblocări în dispozitive critice pentru siguranță, cum ar fi mașini sau aplicații auto.
- Modulul radio XBee nu a fost aprobat pentru utilizare în (această listă nu este exhaustivă):
 - dispozitive medicale
 - aplicații nucleare
 - atmosfere explozive sau inflamabile
- Nu există componente care să poată fi reparate de utilizator în interiorul modulului radio XBee. Nu îndepărtați scutul și nu modificați XBee în niciun fel. Modificările pot exclude modulul din orice garanție și pot face ca radioul XBee să funcționeze în afara conformității cu reglementările pentru o anumită țară, ceea ce duce la o posibilă funcționare ilegală a radioului.
- Folosiți protecția ESD standard în industrie când manipulați modulul XBee.
- Aveți grijă în timpul manipulării pentru a evita deteriorarea electrică a PCB-ului și a componentelor.

- Nu expuneți modulele radio XBee la apă sau umezeală.
- Utilizați acest produs cu antenele specificate în ghidurile utilizatorului modulului XBee.
- Utilizatorului final trebuie să i se spună cum să scoată alimentarea de la modulul radio XBee sau să găsească antenele la 20 cm de oameni sau animale.

Bezpečnostné inštrukcie

moduly XBee

- Rádiový modul XBee nemôže byť zaručený kvôli rádiovému spojeniu, a preto by sa nemal používať na blokovanie v zariadeniach kritických z hľadiska bezpečnosti, ako sú stroje alebo automobilové aplikácie.
- Rádiový modul XBee nebol schválený na použitie v (tento zoznam nie je úplný):
 - zdravotnícke pomôcky
 - jadrové aplikácie
 - výbušné alebo horľavé atmosféry
- Vo vnútri rádiového modulu XBee sa nenachádzajú žiadne používateľsky opraviteľné komponenty. Neodstraňujte štít ani žiadnym spôsobom neupravujte XBee. Úpravy môžu vyňať modul zo záruky a môžu spôsobiť, že rádio XBee bude fungovať mimo zhody s predpismi pre danú krajinu, čo vedie k možnej nezákonnej prevádzke rádia.
- Pri manipulácii s modulom XBee používajte štandardnú ochranu pred ESD.
- Pri manipulácii buďte opatrní, aby ste predišli elektrickému poškodeniu dosky plošných spojov a komponentov.
- Rádiové moduly XBee nevystavujte vode ani vlhkosti.
- Tento produkt používajte s anténami špecifikovanými v používateľských príručkách modulu XBee.
- Koncový používateľ musí byť informovaný o tom, ako odpojiť napájanie rádiového modulu XBee alebo ako umiestniť antény 20 cm od ľudí alebo zvierat.

Varnostna navodila

XBee moduli

- Radijskega modula XBee ni mogoče zagotoviti delovanja zaradi radijske povezave in ga zato ne smete uporabljati za zaklepanje v varnostno kritičnih napravah, kot so stroji ali avtomobilske aplikacije.
- Radijski modul XBee ni bil odobren za uporabo v (ta seznam ni izčrpen):
 - medicinskih pripomočkov
 - jedrske aplikacije
 - eksplozivne ali vnetljive atmosfere
- V radijskem modulu XBee ni komponent, ki bi jih lahko popravil uporabnik. Ne odstranjujte ščita in na noben način ne spreminjajte XBee. Spremembe lahko modul izključijo iz kakršne

koli garancije in lahko povzročijo, da radio XBee deluje zunaj zakonske skladnosti za dano državo, kar vodi do možnega nezakonitega delovanja radia.

- Pri ravnanju z modulom XBee uporabite standardno industrijsko zaščito pred ESD.
- Pri rokovanju pazite, da se izognete električnim poškodbam tiskanega vezja in komponent.
- Radijskih modulov XBee ne izpostavljajte vodi ali vlagi.
- Ta izdelek uporabljajte z antenami, navedenimi v uporabniških priročnikih modula XBee.
- Končnemu uporabniku je treba povedati, kako odstraniti napajanje z radijskega modula XBee ali naj locira antene 20 cm od ljudi ali živali.

Instrucciones de seguridad

Módulos XBee

- No se puede garantizar el funcionamiento del módulo de radio XBee debido al enlace de radio y, por lo tanto, no debe usarse para enclavamientos en dispositivos críticos para la seguridad, como máquinas o aplicaciones automotrices.
- El módulo de radio XBee no ha sido aprobado para su uso en (esta lista no es exhaustiva):
 - dispositivos médicos
 - aplicaciones nucleares
 - atmósferas explosivas o inflamables
- No hay componentes reparables por el usuario dentro del módulo de radio XBee. No quite el escudo ni modifique el XBee de ninguna manera. Las modificaciones pueden excluir el módulo de cualquier garantía y pueden hacer que la radio XBee funcione fuera del cumplimiento normativo de un país determinado, lo que puede provocar una operación ilegal de la radio.
- Utilice la protección ESD estándar de la industria al manipular el módulo XBee.
- Tenga cuidado al manipularlo para evitar daños eléctricos en la PCB y los componentes.
- No exponga los módulos de radio XBee al agua ni a la humedad.
- Utilice este producto con las antenas especificadas en las guías de usuario del módulo XBee.
- Se debe indicar al usuario final cómo desconectar la alimentación del módulo de radio XBee o ubicar las antenas a 20 cm de personas o animales.

Säkerhets instruktioner

XBee-moduler

- XBee-radiomodulen kan inte garanteras funktion på grund av radiolänken och bör därför inte användas för förreglingar i säkerhetskritiska enheter som maskiner eller biltillämpningar.
- XBee-radiomodulen har inte godkänts för användning i (denna lista är inte uttömmande):

- medicinsk utrustning
 - kärnkraftstillämpningar
 - explosiv eller brandfarlig atmosfär
- Det finns inga komponenter som användaren kan reparera inuti XBee-radiomodulen. Ta inte bort skölden eller modifiera XBee på något sätt. Ändringar kan utesluta modulen från alla garantier och kan göra att XBee-radion fungerar utanför bestämmelserna för ett visst land, vilket kan leda till att radion kan användas olagligt.
 - Använd industristandard ESD-skydd när du hanterar XBee-modulen.
 - Var försiktig vid hanteringen för att undvika elektriska skador på kretskortet och komponenterna.
 - Utsätt inte XBee radiomoduler för vatten eller fukt.
 - Använd den här produkten med antennerna som specificeras i XBee-modulens användarguider.
 - Slut användaren måste informeras om hur man kopplar bort strömmen från XBee-radiomodulen eller för att placera antennerna 20 cm från människor eller djur.

Introduction to LoRaWAN

LoRaWAN is a Low-Power Wide Area Network (LPWAN) protocol designed for IoT applications requiring long-range communication, minimal power consumption, and secure data exchange. It operates in unlicensed frequency bands, such as US915 and EU868, and supports a star-of-stars network topology.

This section provides a detailed overview of the LoRaWAN protocol, focusing on its architecture, security, configuration, and practical applications. It is based on LoRaWAN v1.0.4, which introduces enhancements such as improved MAC commands, dynamic channel management via CFList, and stricter security measures.

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LoRaWAN network

Network architecture

End devices (nodes)

These IoT devices are equipped with LoRaWAN modules and are responsible for transmitting uplink data and receiving downlink messages. They operate in one of three device classes: Class A, B, or C.

Gateways

The gateways serve as relays between end devices and the network server, receiving uplink messages on multiple frequencies and forwarding them to the network server via an IP backhaul. They also transmit downlink messages from the network server to devices during their receive windows.

Network server

The network server manages message routing, device authentication, and configuration. This ensures message integrity, de-duplication, and Adaptive Data Rate (ADR) adjustments.

Application server

The application server processes data from end devices for IoT applications, and sends commands or updates to devices via the network server.

Communication workflow

Uplink communication

- Devices transmit messages to gateways using LoRa modulation.
- Gateways forward the messages and their metadata (e.g., RSSI, SNR) to the network server.
- The network server de-duplicates messages, validates integrity, and routes data to the application server.

Downlink communication

- The network server schedules downlink messages for devices.
- Gateways transmit the messages during the device's receive windows.
- Devices process the downlink, which may contain application payloads or MAC commands.

Message types

- Uplink messages:
 - Devices send data frames to the network server, which may include application payloads or MAC commands.
 - Confirmed uplink frames require an acknowledgment from the network server.

- Downlink messages:
 - The network server sends data or MAC commands to the device during its RX windows.
 - Messages may be classified as confirmed (requiring acknowledgment) or unconfirmed (not requiring acknowledgment).
- Join messages:
 - **Join request:** Sent by devices during the OTAA procedure to initiate a session.
 - **Join accept:** Sent by the network server to provide session keys and optional CFList parameters.

LoRaWAN protocol

LoRaWAN is designed to balance long-range communication, low power consumption, and secure data transmission. This section describes the operational classes, protocol updates, and configurable parameters such as data rates, spreading factors, receive delays, and channel frequencies.

Classes of operation

Class A (default class)

- Devices open two short receive windows (RX1 and RX2) after each uplink transmission.
- Receive window details:
 - RX1:
 - Opens after a default delay of 1 second.
 - Operates on the same frequency and data rate as the uplink.
 - RX2:
 - Opens after a default delay of 2 seconds.
 - Uses a fixed frequency and data rate defined by regional parameters.
- Use Case: Ideal for battery-operated sensors transmitting periodic data with minimal downlink requirements.

Class B (beacon-synchronized)

- Devices synchronize with periodic beacons sent by gateways.
- Downlink messages are scheduled during dedicated receive slots.
- Use Case: Suitable for applications requiring predictable downlink communication, such as smart metering.

Class C (continuous listening)

- Devices keep their receive windows open continuously except during uplink transmissions.
- Operational Details:
 - RX2 configuration is crucial for ensuring consistent downlink delivery during continuous listening.

- The server can schedule downlink transmissions at any time, making Class C ideal for time-sensitive applications.
- Use Case: Designed for low-latency applications like industrial control systems, where frequent downlinks are required.
- Power Considerations: Consumes significantly more power compared to Class A and B.

Adaptive Data Rate (ADR)

Adaptive Data Rate (ADR) dynamically optimizes network performance by adjusting device transmission parameters:

- **Advantages:**
 - Improves battery life by reducing transmission time.
 - Enhances network capacity by optimizing channel usage and power levels.
- **Mechanism:**
 - The network server evaluates uplink quality (RSSI, SNR) and sends LinkADRReq MAC commands to adjust the device's data rate, transmission power, and channel mask.
 - Devices must acknowledge LinkADRReq commands to confirm adjustments.

Receive delays

Defines the timing for the two receive windows in Class A devices:

- RX1:
 - Default delay: 1 second after uplink transmission.
 - Operates on the same frequency and data rate as the uplink unless overridden by ADR.
- RX2:
 - Default delay: 2 seconds after uplink transmission.
 - Uses a fixed frequency and data rate specified in the regional parameters.
 - Can be reconfigured using the RXParamSetupReq MAC command.
- Timing considerations:
 - RX1 and RX2 windows must align precisely with the device's internal clock and the network server's scheduling.
 - Variations in clock drift or latency can cause missed packets.
 - Devices should maintain accurate timing by compensating for potential drift to avoid packet loss.

Channel frequencies

LoRaWAN operates on predefined frequency plans to ensure compliance with regional regulations.

EU868 Frequency Plan

- Operates in the 868 MHz band.
- Default uplink channels:

1. 868.1 MHz (DR0 to DR5)
 2. 868.3 MHz (DR0 to DR5)
 3. 868.5 MHz (DR0 to DR5)
- Additional channels can be configured using the CFList parameter.
 - Maximum duty cycle: 1%.

US915 Frequency Plan

- Operates in the 902-928 MHz band.
- Default uplink channels:
 - 64 channels, 125 kHz bandwidth, spaced at 200 kHz intervals (902.3 MHz to 914.9 MHz).
 - 8 channels, 500 kHz bandwidth (903 MHz to 914.6 MHz).
- Default downlink channels:
 - 8 channels, 500 kHz bandwidth, spaced at 600 kHz intervals (923.3 MHz to 927.5 MHz).
- Sub-band selection via CFList enables efficient channel allocation.
- Frequency separation:
 - LoRaWAN ensures uplink and downlink frequencies are separated to minimize interference.
 - This separation is region-specific, adhering to local regulatory standards.

LoRaWAN security

Key management

- **AppKey**: Used during OTAA to derive session keys.
- **NwkSKey**: Secures MAC commands and network communication.
- **AppSKey**: Encrypts and decrypts application payloads.

Encryption and integrity

- **AES-128 Encryption**: Ensures data confidentiality.
- **Message Integrity Code (MIC)**: Prevents message tampering.

Security in OTAA

- Session keys are dynamically generated using unique nonces.
- Replay attacks are mitigated by rejecting duplicate nonces.
- Frame counter role:
 - 'FCntUp' (uplink frame counter) and 'FCntDown' (downlink frame counter) ensure message sequence integrity and prevent replay attacks.
 - Frame counters must be incremented monotonically and managed to avoid overflow conditions.

- Nonce management:
 - Each join procedure generates unique 'DevNonce' and 'AppNonce' values to ensure session key freshness.
 - Duplicated nonces are rejected by the network server to mitigate replay attacks.

LoRaWAN reference

- [LoRaWAN Specification v1.0.4](#)
- [Regional Parameters Documentation](#)
- [LoRaWAN Security Guidelines](#)

Configure the XBee LR LoRaWAN RF Module

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XBee bootloader

You can update firmware on the XBee LR LoRaWAN RF Module serially. This is done by invoking the XBee bootloader and transferring the firmware image using XMODEM.

This process is also used for updating a local device's firmware using XCTU.

XBee devices use a modified version of Silicon Labs' Gecko bootloader. This bootloader version supports a custom entry mechanism that uses module pins DIN, $\overline{\text{DTR/SLEEP_RQ}}$, and $\overline{\text{RTS}}$.

To invoke the bootloader using hardware flow control lines, do the following:

1. Set $\overline{\text{DTR/SLEEP_RQ}}$ low (CMOS0V) and RTS high.
2. Send a serial break to the DIN pin and power cycle or reset the module.
3. When the device powers up, set $\overline{\text{DTR/SLEEP_RQ}}$ and DIN to low (CMOS0V) and $\overline{\text{RTS}}$ should be high.
4. Terminate the serial break and send a carriage return at 115200 baud to the device.
5. If successful, the device sends the Silicon Labs' Gecko bootloader menu out the DOUT pin at 115200 baud.
6. You can send commands to the bootloader at 115200 baud.

Note Disable hardware flow control when entering and communicating with the bootloader.

All serial communications with the module use 8 data bits, no parity bit, and 1 stop bit.

You can also invoke the bootloader from the XBee application by sending [%P \(Invoke Bootloader\)](#).

Send a firmware image

After invoking the bootloader, a menu is sent out the UART at 115200 baud. To upload a firmware image through the UART interface:

1. Look for the bootloader prompt **BL >** to ensure the bootloader is active.
2. Send an ASCII **1** character to initiate a firmware update.
3. After sending a **1**, the device waits for an XModem CRC upload of a .gbl image over the serial line at 115200 baud. Send the .bin file to the device using standard XMODEM-CRC.

If the firmware image is successfully loaded, the bootloader outputs a "complete" string. Invoke the newly loaded firmware by sending a **2** to the device.

If the firmware image is not successfully loaded, the bootloader outputs an "aborted string". It returns to the main bootloader menu. Some causes for failure are:

- Over 1 minute passes after the command to send the firmware image and the first block of the image has not yet been sent.
- A power cycle or reset event occurs during the firmware load.
- A file error or a flash error occurs during the firmware load. The following table contains errors that could occur during the XMODEM transfer.

Error	Cause	Workaround
0x18	This error is observed when a serial upload attempt has been abruptly discontinued by	Press 2 on the bootloader menu. The bootloader performs a reboot

Error	Cause	Workaround
	invoking Ctrl+C and subsequently another attempt is made to upload a .bin by pressing 1 on the bootloader menu.	and the menu gets displayed again. Now press 1 and begin uploading the .bin.

Software libraries

One way to communicate with the XBee LR LoRaWAN RF Module is by using a software library. The libraries available for use with the XBee LR LoRaWAN RF Module include:

- [XBee C library](#)
- [XBee Arduino library](#)

XBee Multi Programmer

The XBee Multi Programmer is a combination of hardware and software that enables partners and distributors to program multiple Digi Radio frequency (RF) devices simultaneously. It provides a fast and easy way to prepare devices for distribution or large networks deployment.

The XBee Multi Programmer board is an enclosed hardware component that allows you to program up to six RF modules thanks to its six external XBee sockets. The XBee Multi Programmer application communicates with the boards and allows you to set up and execute programming sessions. Some of the features include:

- Each XBee Multi Programmer board allows you to program up to six devices simultaneously. Connect more boards to increase the programming concurrency.
- Different board variants cover all the XBee form factors to program almost any Digi RF device.

Download the XBee Multi Programmer application from: digi.com/support/productdetail?pid=5641
See the [XBee Multi Programmer User Guide](#) for more information.

Serial communication

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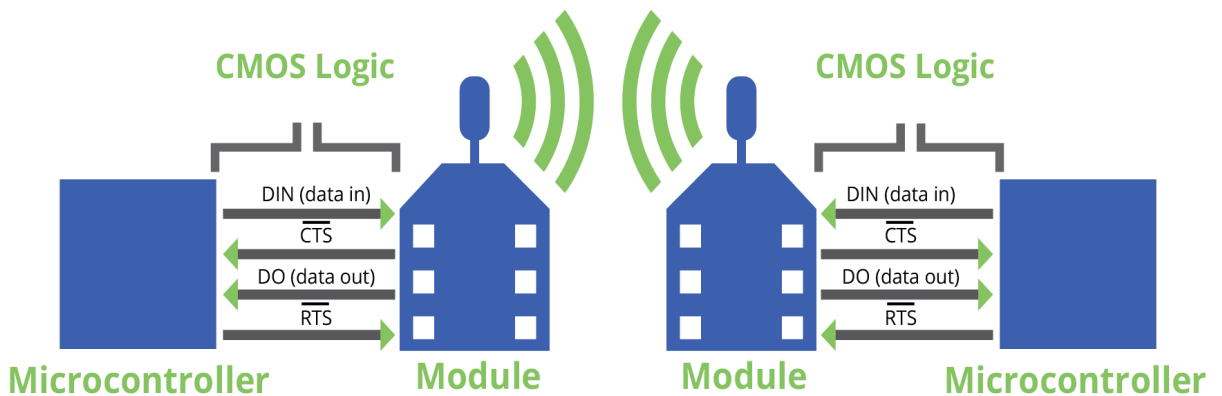
Serial interface

The XBee LR LoRaWAN RF Module interfaces to a host device through a serial port. The device can communicate through its serial port:

- Through logic and voltage compatible universal asynchronous receiver/transmitter (UART).
- Through a level translator to any serial device, for example through an RS-232 or USB interface board.

UART data flow

Devices that have a UART interface connect directly to the pins of the XBee LR LoRaWAN RF Module as shown in the following figure. The figure shows system data flow in a UART-interfaced environment. Low-asserted signals have a horizontal line over the signal name.

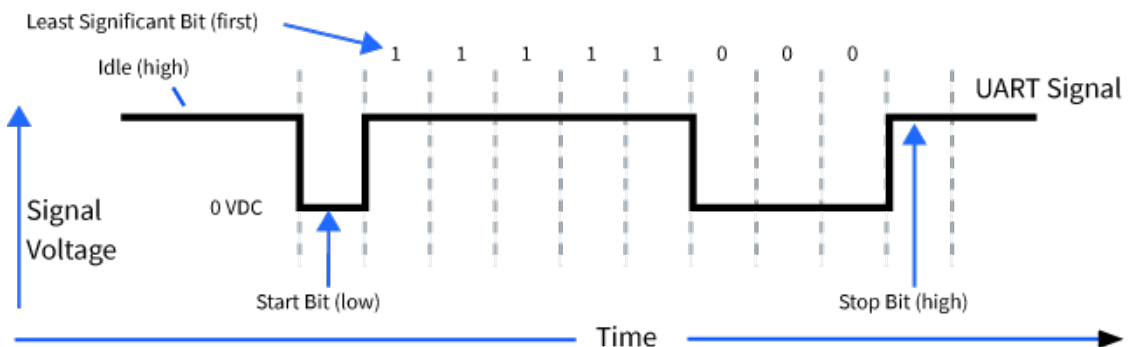


Serial data

A device sends data to the XBee LR LoRaWAN RF Module's UART as an asynchronous serial signal. When the device is not transmitting data, the signals should idle high.

For serial communication to occur, you must configure the UART of both devices (the microcontroller and the XBee LR LoRaWAN RF Module) with compatible settings for the baud rate, parity, start bits, stop bits, and data bits.

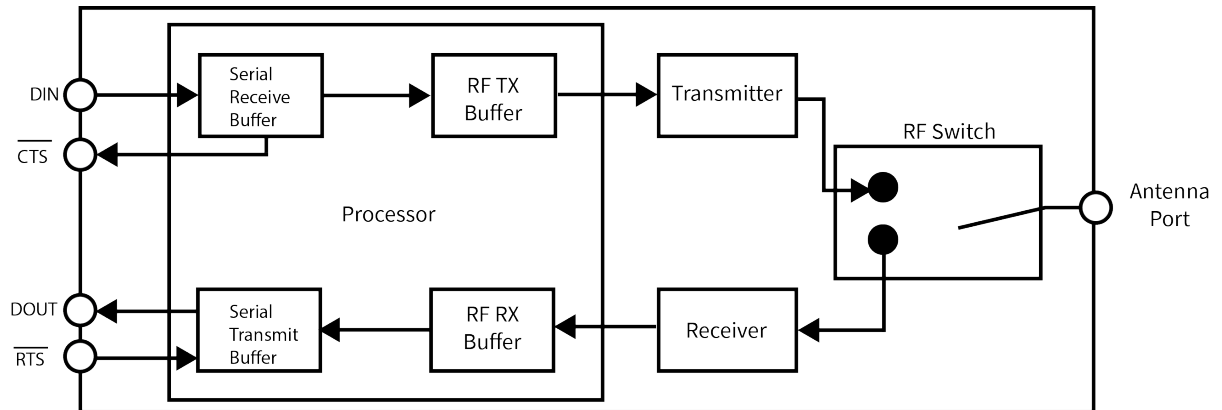
Each data byte consists of a start bit (low), 8 data bits (least significant bit first) and a stop bit (high). The following diagram illustrates the serial bit pattern of data passing through the device. The diagram shows UART data packet 0x1F (decimal number 31) as transmitted through the device.



You can configure the UART baud rate, parity, and stop bits settings on the device with the **BD**, **NB**, and **SB** commands respectively. For more information, see [Serial interfacing commands](#).

Serial buffers

The XBee LR LoRaWAN RF Module maintains internal buffers to collect serial and RF data that it receives. The serial receive buffer collects incoming serial characters and holds them until the device can process them. The serial transmit buffer collects the data it receives via the RF link until it transmits that data out the serial port. The following figure shows the process of device buffers collecting received serial data.



Serial receive buffer

Serial transmit buffer

When the device receives RF data, it moves the data into the serial transmit buffer and sends it out the serial port. If the serial transmit buffer becomes full and the system buffers are also full, then it drops the entire RF data packet. Whenever the device receives data faster than it can process and transmit the data out the serial port, there is a potential of dropping data.

UART flow control

You can use the $\overline{\text{RTS}}$ and $\overline{\text{CTS}}$ pins to provide $\overline{\text{RTS}}$ and/or $\overline{\text{CTS}}$ flow control. $\overline{\text{CTS}}$ flow control provides an indication to the host to stop sending serial data to the device. $\overline{\text{RTS}}$ flow control allows the host to signal the device to not send data in the serial transmit buffer out the UART. To enable $\overline{\text{RTS/CTS}}$ flow control, use the **D6** and **D7** commands.

$\overline{\text{CTS}}$ flow control

If you enable CTS flow control (**D7** command), when the serial receive buffer is 17 bytes away from being full, the device de-asserts $\overline{\text{CTS}}$ (sets it high) to signal to the host device to stop sending serial data.

$\overline{\text{RTS}}$ flow control

If you set **D6 (DIO6/RTS)** to enable $\overline{\text{RTS}}$ flow control, the device does not send data in the serial transmit buffer out the DOUT pin as long as $\overline{\text{RTS}}$ is de-asserted (set high). Do not de-assert $\overline{\text{RTS}}$

for long periods of time or the serial transmit buffer will fill. If the device receives an RF data packet and the serial transmit buffer does not have enough space for all of the data bytes, it discards the entire RF data packet.

If the device sends data out the UART when $\overline{\text{RTS}}$ is de-asserted (set high) the device could send up to five characters out the UART port after $\overline{\text{RTS}}$ is de-asserted.

Break control

If a serial break—DIN held low—signal is sent for over five seconds, the device resets, and it boots into Command mode with default baud settings—9600 baud. Note that after receiving the **OK** prompt, serial break must be released in order to allow input from the keyboard at 9600 baud. If either **P3** or **P4** are not enabled, this break function is disabled.

Modes

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API operating mode

API operating mode is required for all LoRaWAN operations, including **network join**, **uplink transmissions**, and **downlink receptions**. It uses structured communication through API frames to enable these functionalities.

Key features

- Enables LoRaWAN-specific operations such as joining the network, transmitting data, and processing received packets.
- AT commands can still be executed within API mode using the [AT Command Request \(0x08\) frame](#).
 - This allows dynamic module configuration and status checks while staying in API mode

Command mode

Command mode is a state in which the firmware interprets incoming characters as commands. It allows you to modify the device's configuration using parameters you can set using AT commands. When you want to read or set any parameter of the XBee LR DigiMesh RF Module using this mode, you have to send an AT command. Every AT command starts with the letters AT followed by the two characters that identify the command and then by some optional configuration values.

The operating modes of the XBee LR DigiMesh RF Module are controlled by the [AP \(API Enable\)](#) setting, but Command mode is always available as a mode the device can enter while configured for any of the operating modes.

Command mode is available on the UART interface for all operating modes.

Enter Command mode

When using the default configuration values for [GT \(Guard Times\)](#) and [CT \(Command Mode Timeout\)](#), you must enter `+++` preceded and followed by one second of silence—no input—to enter Command mode. However, both [GT](#) and [CC](#) are configurable. This means that the silence before and after the escape sequence—[GT](#)—and the escape characters themselves—[CC](#)—can be changed. For example, if [GT](#) is `5DC` and [CC](#) is `31`, then Command mode can be entered by typing `111` preceded and followed by 1.5 seconds of silence. When the entrance criteria are met the device responds with `OK\r` on UART signifying that it has entered Command mode successfully and is ready to start processing AT commands.

Note Do not press **Return** or **Enter** after typing `+++` because it interrupts the guard time silence and prevents you from entering Command mode.

When the device is in Command mode, it listens for user input and is able to receive AT commands on the UART. If [CT](#) time (default is 10 seconds) passes without any user input, the device drops out of Command mode and returns to the previous operating mode. You can force the device to leave Command mode by sending [CN \(Exit Command mode\)](#).

You can customize the command character, the guard times and the timeout in the device's configuration settings. For more information, see [CC \(Command Character\)](#), [CT \(Command Mode Timeout\)](#) and [GT \(Guard Times\)](#).

Troubleshooting

Failure to enter Command mode is often due to baud rate mismatch. Ensure that the baud rate of the connection matches the baud rate of the device. By default, [BD \(UART Baud Rate\) = 3](#) (9600 b/s).

There are two alternative ways to enter Command mode:

- A serial break for six seconds enters Command mode. You can issue the "break" command from a serial console, it is often a button or menu item.
- Asserting DIN (serial break) upon power up or reset enters Command mode. XCTU guides you through a reset and automatically issues the break when needed.

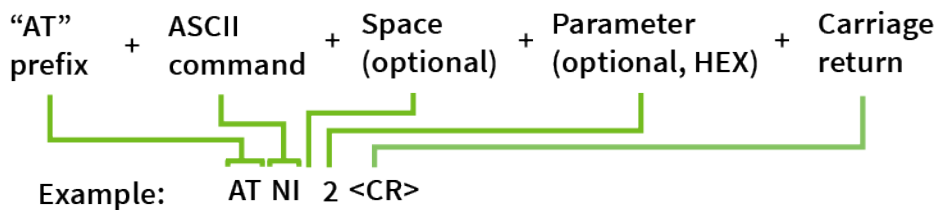
Note You must assert $\overline{\text{RTS}}$ for both of these methods, otherwise the device enters the bootloader.

Both of these methods temporarily set the device's baud rate to 9600 and return an **OK** on the UART to indicate that Command mode is active. When Command mode exits, the device returns to normal operation at the baud rate that **BD** is set to.

Send AT commands

Once the device enters Command mode, use the syntax in the following figure to send AT commands. Every AT command starts with the letters **AT**, which stands for "attention." The AT is followed by two characters that indicate which command is being issued, then by some optional configuration values.

To read a parameter value stored in the device's register, omit the parameter field.



The preceding example changes [NI \(Node Identifier\)](#) to **2**.

Multiple AT commands

You can send multiple AT commands at a time when they are separated by a comma in Command mode; for example, **ATNIMy XBee,AC<cr>**.

Note The behavior of the comma is the same as the behavior of the <CR> in the previous example except that the next command following the comma is not preceded by AT. The only real purpose of the comma is to reduce keystrokes.

The preceding example changes the [NI \(Node Identifier\)](#) to **My XBee** and makes the setting active through [AC \(Apply Changes\)](#).

Parameter format

Refer to the list of [AT commands](#) for the format of individual AT command parameters. Valid formats for hexadecimal values include with or without a leading **0x** for example **FFFF** or **0xFFFF**.

Response to AT commands

When using AT commands to set parameters the XBee LR LoRaWAN RF Module responds with **OK**<cr> if successful and **ERROR**<cr> if not.

Apply command changes

Any changes you make to the configuration command registers using AT commands do not take effect until you apply the changes. For example, if you send the **BD** command to change the baud rate, the actual baud rate does not change until you apply the changes. To apply changes:

1. Send **AC (Apply Changes)**.
2. Send **WR (Write)**. In this case, changes are only applied following a reset. The **WR** command by itself does not apply changes.
or:
3. **Exit Command mode**. You can exit Command mode in two ways: Either enter the **CN** command or wait for Command mode to timeout as specified by the **CT** parameter.

Make command changes permanent

Send a **WR (Write)** command to save the changes. **WR** writes parameter values to non-volatile memory so that parameter modifications persist through subsequent resets.

Send an **RE (Restore Defaults)** followed by **WR** to restore parameters back to their factory defaults. The next time the device is reset the default settings are applied.

Exit Command mode

1. Send **CN (Exit Command mode)** followed by a carriage return.
or:
2. If the device does not receive any valid AT commands within the time specified by **CT (Command Mode Timeout)**, it returns to Transparent or API mode. The default Command mode timeout is 10 seconds.

For an example of programming the device using AT Commands and descriptions of each configurable parameter, see [AT commands](#).

Join mode

Overview

Join mode establishes the module's connection to a LoRaWAN network, configuring session keys and frequency parameters for uplink and downlink communication. The behavior differs for OTAA (Over-the-Air Activation) and ABP (Activation by Personalization).

Triggering Mechanism

Join mode is initiated by sending a [Join Request \(0x14\) API frame](#) to the module.

Process

1. OTAA:
 - A [Join Request \(0x14\) frame](#) is sent to the LoRaWAN server.
 - The server replies with a Join Accept message containing session keys and configuration data.
 - Join status is reported through a [Modem Status Frame \(0x8A\)](#).
2. ABP:
 - A [Join Request \(0x14\) frame](#) triggers an automatic join process.
 - The module bypasses server interaction and directly uses pre-configured session keys (e.g., NwkSKey, AppSKey, and DevAddr).
 - No communication with the server is required, and the join is considered complete immediately.

Optional Join Status Check

In addition to the [Modem Status Frame \(0x8A\)](#), the join status can be checked using the [ATJS command](#).

When in API mode, this AT command can be executed using an [AT Command Request \(0x08\) frame](#).

Key considerations

- **OTAA:** The module retries join attempts automatically if the initial attempt fails.
- **ABP:** Simpler to use but less secure than OTAA because it lacks dynamic session key generation.

Receive and idle modes

Overview

This combined mode defines the module's behavior during transmission idle times and reception windows. The behavior varies depending on the LoRaWAN class (Class A or Class C).

Class-Specific Behavior

Class A (Idle)

The module remains in idle mode between uplink transmissions, conserving power by entering a low-power state.

After an uplink transmission, the module briefly opens RX1 and RX2 windows to receive downlink packets.

Once the RX windows close, the module transitions back to idle mode.

Class C (Receive)

The module continuously listens for downlink packets, remaining in receive mode at all times.

There is no idle state, and power consumption is higher compared to Class A.

Packet Reception (Class A and C)

Incoming packets are delivered as [Receive Packet \(0xD0\)](#) or [Explicit Receive Packet \(0xD1\)](#) API frames.

The Explicit Receive Packet (0xD1) provides detailed metadata, including:

- Signal-to-Noise Ratio (SNR)
- Received Signal Strength Indicator (RSSI)
- Downlink counters
- Port number

Key Features

- Dynamic transitions between idle and receive modes for Class A.
- Continuous reception capability for Class C.
- Detailed metadata provided in 0xD1 frames enhances diagnostics and performance monitoring.

Transmit mode

Overview

Transmit mode allows the XBee LR module to send uplink messages to the LoRaWAN server.

Triggering Mechanism

Transmit mode is initiated by sending a [Transmit Request \(0x50\) API frame](#) to the module.

Process

1. Construct frame: [Create a Transmit Request \(0x50\)](#) frame with the desired payload, port, and acknowledgment (ACK) settings.
2. Send frame: Transmit the frame to the LoRaWAN server.
3. Monitor status:
 - [Transmit Status Frame \(0x89\)](#): Provides the status of the transmission
 - [Explicit Transmit Status Frame \(0xD2\)](#): Used for detailed status reporting, including:
 - Signal quality metrics (RSSI/SNR)
 - Uplink counter values
 - Confirmation of ACK receipt.

Key Features

- Configurable payload and options for ACK handling.
- Feedback on transmission success or failure through status frames.

Sleep mode

Sleep modes allow the device to enter states of low power consumption when not in use. The XBee LR LoRaWAN RF Module supports both pin sleep (Sleep mode entered on pin transition) and cyclic sleep (device sleeps for a fixed time).

Overview

The XBee LR module manages sleep operations automatically based on the configured LoRaWAN class. No explicit commands are required to enter or exit sleep mode.

Class-specific behavior

Class A

The module sleeps between uplink transmissions and RX windows to conserve power. The processor enters a low-power state during these intervals.

Class C

Sleep mode is not applicable. The module remains active, continuously listening for downlink packets.

Key features

- Dynamic power management for energy efficiency.
- Fully automated based on LoRaWAN class behavior.

AT commands

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LoRaWAN commands

DE (Device EUI)

Reads the LoRaWAN 64 bit unique identifier (DevEUI).

API configuration commands

The following commands affect how API mode operates.

AP (API Enable)

Determines the API mode for the UART interface.

Parameter range

0 - 4

Parameter	Description
0	API disabled (operate in Transparent mode)
1	API enabled
2	API enabled (with escaped control characters)

Default

0

AO (API Options)

This command sets the API Options for the Receive Frame and Transmit Status Type.

It allows a user to select to either use [Receive API Frame\(0xD0\)](#) or the [Explicit Receive API Frame \(0xD1\)](#) and [Transmit Status Frame\(0x89\)](#) or [Explicit Transmit Status Frame\(0xD2\)](#).

This command requires a value to be passed. See the example below.

Parameter range

0x00 - 0x11

Parameter	Description
0x00	Sets to use Receive Frame(0xD0) and Transmit Status Frame(0x89).
0x01	Sets to use Explicit Receive Frame(0xD1) and Transmit Status Frame(0x89).
0x10	Sets to use Receive Frame(0xD0) and Explicit Transmit Status Frame(0xD2).
0x11	Sets to use Explicit Receive Frame(0xD1) and Explicit Transmit Status Frame (0xD2).

Default

0x00

Example

ATAO 0

AT Command options

The following commands affect how [Command mode](#) operates.

CC (Command Character)

Sets or displays the character value used to break from data mode to Command mode. The command character must be sent three times in succession while observing the minimum guard time (**GT**) of silence before and after this sequence.

The default value (**0x2B**) is the ASCII code for the plus (+) character. You must enter it three times within the guard time to enter Command mode. To enter Command mode, there is also a required period of silence before and after the command sequence characters of the Command mode sequence (**GT + CC + GT**). The period of silence prevents inadvertently entering Command mode. For more information, see [Enter Command mode](#).

Parameter range

0 - 0xFF

Recommended: 0x20 - 0x7F (ASCII)

Default

0x2B (the ASCII plus character: +)

CT (Command Mode Timeout)

Sets or displays the Command mode timeout parameter. If the local device enters Command mode and does not receive any valid AT commands within this time period, Command mode silently exits.

Parameter range

2 - 0x28F

Default

0x64 (10 seconds)

GT (Guard Times)

Set the required period of silence before and after the command sequence characters of the Command mode sequence, **GT + CC + GT**. The period of silence prevents inadvertently entering Command mode if a data stream in Transparent mode includes the **CC** character. For more information, see [Enter Command mode](#).

Parameter range

0x2 - 0xCE4 (x 1 ms)

Default

0x3E8 (one second)

CN (Exit Command mode)

Executable command. CN immediately exits Command mode and applies pending changes.

Parameter range

N/A

Default

N/A

UART commands

ATBD (UART Command for Baud Rate)

This command sets the Baud Rate of the UART.

Parameter range

1200 - 967680

Default

N/A

Example

ATBD 2580

ATGT (UART Command for Guard Time)

This command sets the Guard Time of the UART.

Parameter range

2 - UART_MAX_GT

Default

N/A

Example

ATGT 3E8

ATNB (UART Command for Parity Bits)

This command sets the Parity Bits of the UART.

Parameter range

0-4

Default

N/A

Example

ATNB 0

ATFT (UART Command for Flow Threshold)

This command sets the Flow Threshold of the UART.

Parameter range

FT_MIN to FT_MAX

Default

N/A

ATSB (UART Command for Stop Bits)

This command sets the Stop Bits of the UART.

Parameter range

0-1

Default

N/A

Example

ATSB 0

ATFL (UART Command for Flow Control)

This command sets the Flow Control of the UART.

Parameter range

0-1

Default

N/A

Example

ATFL 0

LoRaWAN network commands

ATAE (LoRaWAN APP EUI Command)

This command sets the APP EUI for the LoRaWAN. Each byte is a Hexadecimal value from 0x00 to 0x0F. There should be exactly 8 bytes.

Parameter range

Number of Params = 8

Default

N/A

Example

```
ATAE 1122334455667788
```

ATNK (LoRaWAN Network Key Command)

This command sets the Network Key for the LoRaWAN. Each byte is a Hexadecimal value from 0x00 to 0x0F. There should be exactly 16 bytes.

Parameter range

Number of params = 16

Default

N/A

Example

```
ATNK 1122334455667788990A0B0C0D0E0F00
```

ATAK (LoRaWAN Application Key Command)

This command sets the Application Key for the LoRaWAN. Each byte is a Hexadecimal value from 0x00 to 0x0F. There should be exactly 16 bytes.

Parameter range

Number of params = 16 bytes

Default

N/A

Example

```
ATAK 1122334455667788990A0B0C0D0E0F00
```

ATNS (LoRaWAN Network Session Key Command)

This command sets the Network Session Key for the LoRaWAN. Each byte is a Hexadecimal value from 0x00 to 0x0F. There should be exactly 16 bytes.

Parameter range

Number of params = 16

Default

N/A

Example

```
ATNS 1122334455667788990A0B0C0D0E0F00
```

ATAS (LoRaWAN Application Session Key Command)

This command sets the Application Session Key for the LoRaWAN. Each byte is a Hexadecimal value from 0x00 to 0x0F. There should be exactly 16 bytes.

Parameter range

Number of params = 16

Default

N/A

Example

ATAS 1122334455667788990A0B0C0D0E0F00

ATDE (LoRaWAN Dev EUI Command)

This command sets the Dev EUI for the LoRaWAN. Each byte is a Hexadecimal value from 0x00 to 0x0F. There should be exactly 8 bytes.

Parameter range

Number of Params = 8

Default

N/A

Example

ATAE 1122334455667788

ATDA (LoRaWAN Device Address Command)

This command sets the Device Address for the LoRaWAN. Each byte is a Hexadecimal value from 0x00 to 0x0F. There should be exactly 4 bytes.

Parameter range

Number of Params = 8

Default

N/A

Example

ATDA 11223344

ATLC (LoRaWAN Class Command)

This command sets the Class for the LoRaWAN.

Parameter range

'A', 'B' or 'C'

Default

N/A

Example

ATLC C

ATAM (LoRaWAN Activation Mode Command)

This command sets the Activation Mode (OTAA/ABP) for the LoRaWAN.

Parameter range

0: None

1: ABP

2: OTAA

Default

N/A

Example

ATAM 2

LoRaWAN config commands

ATNW (LoRaWAN Network ID Command)

This command sets the Network ID for the LoRaWAN.

Parameter range

0 to 127

Default

N/A

Example

ATNW 0

ATJS (LoRaWAN Join Status Command)

This command sets the Join Status for the LoRaWAN.

Parameter range

N/A

Default

N/A

Returns

0 or 1

Example

ATJS

ATAD (LoRaWAN Adaptive Data Rate Command)

This command sets the Adaptive Data Rate for the LoRaWAN.

Parameter range

0 or 1

Default

N/A

Example

ATAD 0

ATDR (LoRaWAN Data Rate Command)

This command sets the Data Rate for the LoRaWAN.

Note The Data Rate ranges will be dependent on the LoRaWAN Region

Parameter range

0x00 to 0x0F

Default

N/A

Example

ATDR 0

ATLR (LoRaWAN Band Command)

This command sets the Region for the LoRaWAN.

Parameter range

0 to 9

Default

N/A

Example

ATLR 8

ATDC (LoRaWAN Duty Cycle Command)

This command sets the Duty Cycle for the LoRaWAN.

Parameter range

0 or 1

Default

N/A

Example

ATDC 1

ATLV (LoRaWAN Version Command)

This command checks the version for the LoRaWAN.

Parameter range

N/A

Default

N/A

Example

ATLV

ATJ1 (LoRaWAN Join RX1 Delay Command)

This command sets the Join RX1 Delay for the LoRaWAN.

Parameter range

32 bit unsigned integer

Default

N/A

Example

ATJ1 FF

ATJ2 (LoRaWAN Join RX2 Delay Command)

This command sets the Join RX2 Delay for the LoRaWAN.

Parameter range

N/A

Default

N/A

Example

ATJ2 FF

ATD1 (LoRaWAN RX1 Delay Command)

This command sets the RX1 Delay for the LoRaWAN.

Parameter range

Default = 1000

Default

N/A

Example

ATD1 FF

ATD2 (LoRaWAN RX2 Delay Command)

This command sets the RX2 Delay for the LoRaWAN.

Parameter range

Default = 2000

Default

N/A

Example

ATD2 FF

ATXD (LoRaWAN RX2 Data Rate Command)

This command sets the RX2 Data Rate for the LoRaWAN.

Note The Data Rate ranges will be dependent on the LoRaWAN Region.

Parameter range

Range depends on RX2 Data Rates of the Active LoRaWAN Region.

Default

N/A

Example

ATXD 8

ATXF (LoRaWAN RX2 Frequency Command)

This command sets the RX2 Frequency for the LoRaWAN.

Note The Frequency ranges will be dependent on the LoRaWAN Region.

Parameter range

RX2 Frequency Ranges based on the Active LoRaWAN Region.

Default

N/A

Example

ATXF 370870A0

ATPO (LoRaWAN Transmit Power Command)

This command sets the Transmit Power for the LoRaWAN.

Note The Transmit Power will be dependent on the LoRaWAN Region.

Parameter range

0x00 to 0x0F

Default

N/A

Example

ATPO 0D

VR (Firmware Version)

Reads the firmware version on a device.

The most significant byte represents the hardware and region. See [R? \(Region Code\)](#) for available region values.

Parameter range

0x1000 - 0xFFFF [read-only]

Default

Set in the firmware

VL (Version Long)

Shows detailed version information including the application build date and time.

Parameter range

Multi-line string [read-only]

Default

N/A

VH (Bootloader Version)

Reads the bootloader version of the device.

Parameter range

N/A

Default

N/A

HV (Hardware Version)

Display the hardware version number and revision number of the device. The upper byte is the Hardware version and the lower byte is the hardware revision.

The hardware version distinguishes one radio type from another.

The hardware revision for a particular module can change for a variety of reasons and should not be used as the sole determination that a module's functionality has changed from previous revisions. The revision may change for various reasons including a new software version, a minor hardware modification, or even due to a label update. Furthermore, the firmware on a module may

be upgraded or downgraded by a user thus making it different from the firmware version it was manufactured with. Thus the revision number is not a reliable indicator of the firmware version on the module. If an explanation for the revision number is not found in the release notes and it is a concern, contact Digi Support. In most cases the revision number does not relay any useful information to the consumer and it can be ignored.

Parameter range

0 - 0xFFFF [read-only]

Pre-defined **HV** values for XBee 3 devices:

- 0x41 = XBee 3 Micro (MMT) and Surface Mount (SMT)
- 0x42 = XBee 3 Through Hole (TH)

Default

Set in the factory

CK (Configuration Checksum)

Reads the cyclic redundancy check (CRC) of the current AT command configuration settings to determine if the configuration has changed.

After a firmware update this command may return a different value.

Parameter range

0 - 0xFFFF [read-only]

Default

N/A

%P (Invoke Bootloader)

Forces the device to reset into the bootloader menu.

This command can only be issued locally.

Parameter range

N/A

Default

N/A

Memory access commands

This section details the executable commands that provide memory access to the device.

FR (Software Reset)

Resets the device. The device responds immediately with an **OK** and performs a reset 100 ms later.

If you issue **FR** while the device is in Command mode, the reset effectively exits Command mode.

Parameter range

N/A

Default

N/A

AC (Apply Changes)

This command applies changes to all command parameters configured in Command mode.

Any of the following also applies changes the same as issuing an **AC** command:

- Exiting Command mode with a **CN** command.
- Exiting Command mode via timeout.
- Receiving a 0x08 API command frame.
- Issuing a 0x08 Local AT Command API frame.
- Issuing a remote 0x17 AT Command API frame with option bit 1 set.

Example: Altering the UART baud rate with the **BD** command does not change the operating baud rate until after an **AC** command is received; at this point, the interface immediately changes baud rates.

Parameter range

N/A

Default

N/A

WR (Write)

Immediately writes parameter values to non-volatile flash memory so they persist through a power cycle. .

Note Once you issue a **WR** command, do not send any additional characters to the device until after you receive the **OK** response. Use the **WR** command sparingly; the device's flash only supports 10,000 erase/write cycles.

Parameter range

N/A

Default

N/A

RE (Restore Defaults)

Restore all device parameters to factory defaults but do not apply the parameters.

Parameter range

N/A

AT commands

Memory access commands

Default

N/A

Operate in API mode

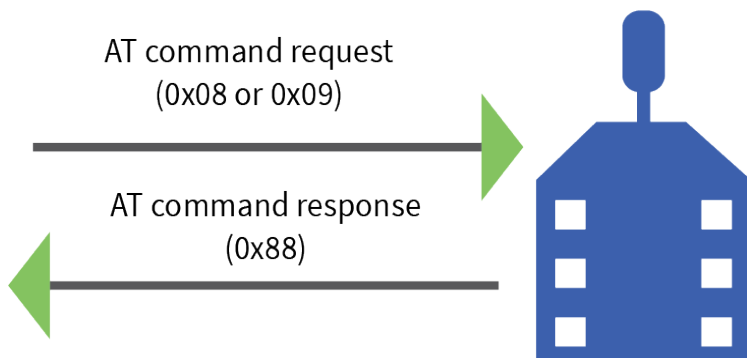
API serial exchanges	63
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API serial exchanges

You can use the Frame ID field to correlate between the outgoing frames and associated responses.

AT commands

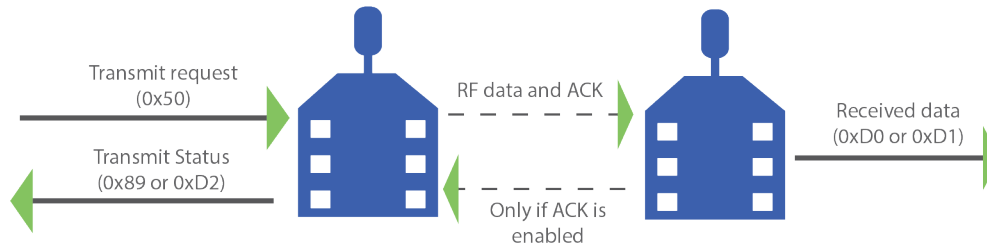
The following image shows the API frame exchange that takes place at the serial interface when sending an AT command request to read or set a device parameter. You can disable the response by setting the frame ID to 0 in the request.



Transmit and Receive RF data

The following image shows the API frames exchange that take place at the UART interface when sending RF data to another device. The transmit status frame is always sent at the end of a data transmission unless the frame ID is set to 0 in the TX request. If the packet cannot be delivered to the destination, the transmit status frame indicates the cause of failure.

The received data frame type (0xD0 or 0xD1) is determined by the **AO** command.

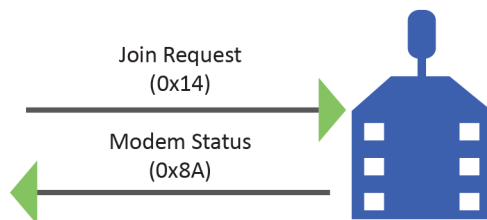


Remote AT commands

Note Support is not yet available for Remote AT commands.

LoRaWAN Join Activation

The following image illustrates the API frame exchanges that occur over the serial interface when registering a device to join a LoRaWAN network.



API frame format

An API frame consists of the following:

- Start delimiter
- Length
- Frame data
- Checksum

API operation (AP parameter = 1)

This is the recommended API mode for most applications. The following table shows the data frame structure when you enable this mode:

Frame fields	Byte	Description
Start delimiter	1	0x7E
Length	2 - 3	Most Significant Byte, Least Significant Byte
Frame data	4 - number (n)	API-specific structure
Checksum	n + 1	1 byte

Any data received prior to the start delimiter is silently discarded. If the frame is not received correctly or if the checksum fails, the XBee replies with a radio status frame indicating the nature of the failure.

API operation with escaped characters (AP parameter = 2)

Setting API to 2 allows escaped control characters in the API frame. Due to its increased complexity, we only recommend this API mode in specific circumstances. API 2 may help improve reliability if the serial interface to the device is unstable or malformed frames are frequently being generated.

When operating in API 2, if an unescaped 0x7E byte is observed, it is treated as the start of a new API frame and all data received prior to this delimiter is silently discarded. For more information on using this API mode, see the [Escaped Characters and API Mode 2](#) in the Digi Knowledge base.

API escaped operating mode works similarly to API mode. The only difference is that when working in API escaped mode, the software must escape any payload bytes that match API frame specific data, such as the start-of-frame byte (0x7E). The following table shows the structure of an API frame with escaped characters:

Frame fields	Byte	Description
Start delimiter	1	0x7E
Length	2 - 3	Most Significant Byte, Least Significant Byte
Frame data	4 - n	API-specific structure
Checksum	n + 1	1 byte

Start delimiter field

This field indicates the beginning of a frame. It is always 0x7E. This allows the device to easily detect a new incoming frame.

Escaped characters in API frames

If operating in API mode with escaped characters (AP parameter = 2), when sending or receiving a serial data frame, specific data values must be escaped (flagged) so they do not interfere with the data frame sequencing. To escape an interfering data byte, insert 0x7D and follow it with the byte to be escaped (XORed with 0x20).

The following data bytes need to be escaped:

- 0x7E: start delimiter
- 0x7D: escape character
- 0x11: XON
- 0x13: XOFF

Note Since software flow control is not implemented on this device, having hex values of 0x11 and 0x13 in the API frame isn't a reason to use AP = 2. Since 0x7D is the escape character itself, the only value of AP = 2 is to distinguish a 0x7E in the data compared to the start delimiter 0x7E.

To escape a character:

1. Insert 0x7D (escape character).
2. Append it with the byte you want to escape, XORed with 0x20.

In API mode with escaped characters, the length field does not include any escape characters in the frame and the firmware calculates the checksum with non-escaped data.

Example: escape an API frame

To express the following API non-escaped frame in API operating mode with escaped characters:

Start delimiter	Length	Frame type	Frame Data		Checksum
			Data		
7E	00 0F	17	01 00 13	A2 00 40 AD 14 2E FF FE 02 4E 49 6D	

You must escape the 0x13 byte:

1. Insert a 0x7D.
2. XOR byte 0x13 with 0x20: $13 \oplus 20 = 33$

The following figure shows the resulting frame. Note that the length and checksum are the same as the non-escaped frame.

Start delimiter	Length	Frame type	Frame Data		Checksum
			Data		
7E	00 0F	17	01 00 7D 33	A2 00 40 AD 14 2E FF FE 02 4E 49 6D	

The length field has a two-byte value that specifies the number of bytes in the frame data field. It does not include the checksum field.

Length field

The length field is a two-byte value that specifies the number of bytes contained in the frame data field. It does not include the checksum field.

Frame data

This field contains the information that a device receives or will transmit. The structure of frame data depends on the purpose of the API frame:

Start delimiter	Length		Frame type	Frame data							Checksum
				Data							
1	2	3	4	5	6	7	8	9	...	n	n+1
0x7E	MSB	LSB	API frame type	Data							Single byte

- **Frame type** is the API frame type identifier. It determines the type of API frame and indicates how the Data field organizes the information.
- **Data** contains the data itself. This information and its order depend on the what type of frame that the Frame type field defines.

Multi-byte values are sent big-endian.

Calculate and verify checksums

To calculate the checksum of an API frame:

1. Add all bytes of the packet, except the start delimiter 0x7E and the length (the second and third bytes).
2. Keep only the lowest 8 bits from the result.
3. Subtract this quantity from 0xFF.

To verify the checksum of an API frame:

1. Add all bytes including the checksum; do not include the delimiter and length.
2. If the checksum is correct, the last two digits on the far right of the sum equal 0xFF.

Frame descriptions

The following sections describe the API frames.

Local AT Command Request - 0x08	69
Queue Local AT Command Request - 0x09	70
LoRaWAN Join Request - 0x14	72
LoRaWAN Transmit Request - 0x50	72
LoRaWAN Explicit Transmit Status - 0x51	73
Modem Status - 0x8A	75
Local AT Command Response - 0x88	75
Transmit Status - 0x89	77
LoRaWAN Receive Packet - 0xD0	78
LoRaWAN Explicit Receive Packet - 0xD1	78
LoRaWAN Explicit Transmit Status Packet - 0xD2	79

Local AT Command Request - 0x08

Response frame: [Local AT Command Response - 0x88](#)

Description

This frame type is used to query or set command parameters on the local device. Any parameter that is set with this frame type will apply the change immediately. If you wish to queue multiple parameter changes and apply them later, use the [Queue Local AT Command Request - 0x09](#) instead.

When querying parameter values, this frame behaves identically to [Queue Local AT Command Request - 0x09](#): You can query parameter values by sending this frame with a command but no parameter value field—the two-byte AT command is immediately followed by the frame checksum. When an AT command is queried, a [Local AT Command Response - 0x88](#) frame is populated with the parameter value that is currently set on the device. The Frame ID of the 0x88 response is the same one set by the command in the 0x08 request frame.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Local AT Command Request - 0x08
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a subsequent response. If set to 0 , the device will not emit a response frame.
5	16-bit	AT command	The two ASCII characters that identify the AT Command.
7-n	variable	Parameter value (optional)	If present, indicates the requested parameter value to set the given register. If no characters are present, it queries the current parameter value and returns the result in the response.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Examples

Each example is written without escapes (**AP = 1**) and all bytes are represented in hex format. For brevity, the start delimiter, length, and checksum fields have been excluded.

Set the local command parameter

Set the NI string of the radio to "End Device".

The corresponding [Local AT Command Response - 0x88](#) with a matching Frame ID will indicate whether the parameter change succeeded.

7E 00 0E 08 A1 4E 49 45 6E 64 20 44 65 76 69 63 65 38

Frame type	Frame ID	AT command	Parameter value
0x08	0xA1	0x4E49	0x456E6420446576696365
<i>Request</i>	<i>Matches response</i>	<i>"NI"</i>	<i>"End Device"</i>

Query local command parameter

Query the temperature of the module—TP command.

The corresponding [Local AT Command Response - 0x88](#) with a matching Frame ID will return the temperature value.

7E 00 04 08 17 54 50 3C

Frame type	Frame ID	AT command	Parameter value
0x08	0x17	0x5450	(omitted)
<i>Request</i>	<i>Matches response</i>	<i>"TP"</i>	<i>Query the parameter</i>

Queue Local AT Command Request - 0x09

Response frame: [Local AT Command Response - 0x88](#)

Description

This frame type is used to query or set queued command parameters on the local device. In contrast to [Local AT Command Request - 0x08](#), this frame queues new parameter values and does not apply them until you either:

- Issue a Local AT Command using the 0x08 frame
- Issue an **AC** command—queued or otherwise

When querying parameter values, this frame behaves identically to [Local AT Command Request - 0x08](#): You can query parameter values by sending this frame with a command but no parameter value field—the two-byte AT command is immediately followed by the frame checksum. When an AT command is queried, a [Local AT Command Response - 0x88](#) frame is populated with the parameter value that is currently set on the device. The Frame ID of the 0x88 response is the same one set by the command in the 0x09 request frame.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.

Offset	Size	Frame Field	Description
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Queue Local AT Command Request - 0x09
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a subsequent response. If set to 0 , the device will not emit a response frame.
5	16-bit	AT command	The two ASCII characters that identify the AT Command.
7-n	variable	Parameter value (optional)	If present, indicates the requested parameter value to set the given register at a later time. If no characters are present, it queries the current parameter value and returns the result in the response.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Examples

Each example is written without escapes (**AP** = 1) and all bytes are represented in hex format. For brevity, the start delimiter, length, and checksum fields have been excluded.

Queue setting local command parameter

Set the UART baud rate to 115200, but do not apply changes immediately.

The device will continue to operate at the current baud rate until the change is applied with a subsequent **AC** command.

The corresponding [Local AT Command Response - 0x88](#) with a matching Frame ID will indicate whether the parameter change succeeded.

7E 00 05 09 53 42 44 07 16

Frame type	Frame ID	AT command	Parameter value
0x09	0x53	0x4244	0x07
<i>Request</i>	<i>Matches response</i>	<i>"BD"</i>	<i>7 = 115200 baud</i>

Query local command parameter

Query the temperature of the module (**TP** command).

The corresponding [0x88 - Local AT Command Response](#) frame with a matching Frame ID will return the temperature value.

7E 00 04 09 17 54 50 3B

Frame type	Frame ID	AT command	Parameter value
0x09	0x17	0x5450	(omitted)
<i>Request</i>	<i>Matches response</i>	<i>"TP"</i>	<i>Query the parameter</i>

LoRaWAN Join Request - 0x14

Description

This frame initiates a join request to connect to a LoRaWAN network.

Format

The following table provides the contents of the frame. For details on the frame structure, see [API frame format](#).

Join Status will be reported in Modem Status Frame.

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Transmit Status - 0x14
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a subsequent response frame. If set to 0 , the device will not emit a response frame.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Note The join status will be reported in the [Modem Status \(0x8A\)](#) frame. Optionally, the join status can also be queried using the [ATJS](#) command.

Example

The following frame initiates a join request with Frame ID 0x01.

```
7E 00 02 01 E4
```

LoRaWAN Transmit Request - 0x50

Description

This frame sends data to a LoRaWAN server.

Format

The following table provides the contents of the frame. For details on the frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Transmit Status - 0x10
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a subsequent response frame. If set to 0 , the device will not emit a response frame.
5	8-bit	Port	LoRaWAN port
6	8-bit	Transmit options	See the Transmit options bit field table below for available options. If set to 0 , the value of TO specifies the transmit options.
7-n	variable	Payload data	Data to be sent to the LoRaWAN server
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Transmit options bit field

Bitfield options can be combined. Set all unused bits to **0**.

Bit	Meaning	Description
0	Enable ACK [0x01]	Disable/Enable ACKs

Example

The following frame indicates the payload "Hello" has been sent on port 1 with ACK enabled:

```
7E 00 06 50 01 01 48 65 6C 6C 6F
```

LoRaWAN Explicit Transmit Status - 0x51

Description

This frame type provides detailed status information for explicit transmit requests.

Format

Offset	Size	Frame Field	Description
0	8-bit	Start	Indicates the start of an API frame.

Offset	Size	Frame Field	Description
		Delimiter	
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Transmit Status - 0x51
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a prior request.
5	8-bit	Delivery status	Indicates success or failure. Complete list of delivery statuses: 0x00 = Success 0x01 = No ACK received 0x22 = Not joined to network
6	8-bit	Data rate	The data rate used for transmission.
7	8-bit	Channel	The RF channel used.
8	8-bit	Power level	The transmission power level.
9-12	32-bit	Downlink counter	Counter for downlink messages.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Example

The following frame indicates that the transmit succeeded using the following offsets:

- Data rate: 3
- Channel: 18
- Power level: 5
- Downlink counter: 1

7E 00 0B 51 01 00 03 12 05 00 00 00 01

Modem Status - 0x8A

Description

This frame type is emitted in response to specific conditions. The status field of this frame indicates the device behavior.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Modem Status - 0x8A
4	8-bit	Modem status	Complete list of modem statuses: 0x00 = Hardware reset or power up 0x01 = Watchdog timer reset 0x02 = Joined network 0x03 = Left network/Not Joined
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Examples

The following frame indicates the device has joined the network:

```
7E 00 02 8A 02
```

Local AT Command Response - 0x88

Request frames:

- [Local AT Command Request - 0x08](#)
- [Queue Local AT Command Request - 0x09](#)

Description

This frame type is emitted in response to a local AT Command request. Some commands send back multiple response frames; for example, [ND \(Network Discovery\)](#). Refer to individual AT command descriptions for details on API response behavior.

This frame is only emitted if the Frame ID in the request is non-zero.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Local AT Command Response - 0x88
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a prior request.
5	16-bit	AT command	The two ASCII characters that identify the AT Command.
7	8-bit	Command status	Status code for the host's request: 0 = OK 1 = ERROR 2 = Invalid command 3 = Invalid parameter
8-n	variable	Command data (optional)	If the host requested a command parameter change, this field will be omitted. If the host queried a command by omitting the parameter value in the request, this field will return the value currently set on the device.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Examples

Each example is written without escapes (**AP = 1**) and all bytes are represented in hex format. For brevity, the start delimiter, length, and checksum fields have been excluded.

Set local command parameter

Host set the NI string of the local device to "**End Device**" using a 0x08 request frame.

The corresponding [Local AT Command Response - 0x88](#) with a matching Frame ID is emitted as a response:

```
7E 00 05 88 01 4E 49 00 DF
```

Frame type	Frame ID	AT command	Command Status	Command data
0x88	0xA1	0x4E49	0x00	(omitted)

Frame type	Frame ID	AT command	Command Status	Command data
<i>Response</i>	<i>Matches request</i>	<i>"NI"</i>	<i>Success</i>	<i>Parameter changes return no data</i>

Query local command parameter

Host queries the temperature of the local device—TP command—using a 0x08 request frame.

The corresponding [Local AT Command Response - 0x88](#) with a matching Frame ID is emitted with the temperature value as a response:

```
7E 00 07 88 01 54 50 00 FF FE D5
```

Frame type	Frame ID	AT command	Command Status	Command data
0x88	0x17	0x5450	0x00	0xFFFFE
<i>Response</i>	<i>Matches request</i>	<i>"TP"</i>	<i>Success</i>	<i>-2 °C</i>

Transmit Status - 0x89

Request frames:

Description

This frame type is emitted when a transmit request completes. The status field of this frame indicates whether the request succeeded or failed and the reason.

This frame is only emitted if the Frame ID in the request is non-zero.

Note This frame format is deprecated and should only be used by customers who require compatibility with legacy Digi RF products.

Note Broadcast transmissions are not acknowledged and always return a status of **0x00**, even if the delivery failed.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Transmit Status - 0x89

Offset	Size	Frame Field	Description
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a prior request.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

LoRaWAN Receive Packet - 0xD0

Description

This frame is emitted when the device receives a LoRaWAN packet.

Format

This frame type is emitted when a device receives a LoRaWAN packet.

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Transmit Status - 0x90
4	8-bit	Port	LoRaWAN port on which the packet was received.
5-n	Variable	Received data	The RF payload data that the device receives.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Examples

The following frame indicates the device received the payload "Hello" on port 1:

```
7E 00 03 D0 01 48 65 6C 6C 6F
```

LoRaWAN Explicit Receive Packet - 0xD1

Description

This frame is emitted when the device receives a LoRaWAN packet with additional metadata.

Format

This frame type is emitted when a device receives a LoRaWAN packet. Contains more information than LoRaWAN Receive Packet - 0x90.

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Transmit Status - 0x90
4	8-bit	Port	LoRaWAN port to use.
5	8-bit	RSSI	Received Signal Strength Indicator.
6	8-bit	SNR	Signal-to-noise ratio of the received packet.
7	8-bit	DR	Data rate used for transmission.
8-11	32-bit	Downlink Counter	Unsigned counter for downlink messages.
12	8-bit	Receive options	Bitfield with receive options: Bit 0: 1 = ACK Sent
13-n	Variable	Received data	The RF payload data that the device receives.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Example

The following frame indicates the device received "Hello" on port 1 with metadata:

```
7E 00 0B D1 01 B1 0B 03 00 00 00 01 00 48 65 6C 6C 6F
```

LoRaWAN Explicit Transmit Status Packet - 0xD2

Description

This frame is emitted when a transmit request completes. It contains additional details compared to the [LoRaWAN Transmit Status \(0x89\)](#), including data rate, channel, and power information.

Format

The following table provides the contents of the frame. For details on the frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Explicit Transmit Status Packet - 0xD2
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a subsequent response frame.
5	8-bit	Delivery status	Indicates the result of the transmission: 0x00 : Success 0x01 : No ACK received 0x22 : Not joined to network
6	8-bit	DR	Data rate used for transmission.
7	8-bit	Channel	RF channel used for transmission (range: 0-63).
8	8-bit	Power	Transmission power level.
9-12	32-bit	Downlink counter	Unsigned counter for downlink messages.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Example

The following frame indicates that an explicit transmit succeeded with the following values:

- Data rate: 3
- Channel: 18
- Power level: 5
- Downlink counter: 1

7E 00 0C D2 01 00 03 12 05 00 00 00 01
