BLUETOOTH MODULE

To Crownhill associates

No. HD－SHG－GT02221

受付　041010

New　~~Change~~

新規・~~変更~~

Specification report

納 入 仕 様 書

Module name

品名　　EYMF2CAMM－XV

領印欄

We hereby the specification.

この書類の内容を確認し受領致しました。

Received by

〈御受領印〉　　DATE :

DATE :

Submitted by TAIYO YUDEN Co.,Ltd.

太陽誘電株式会社 モジュール事業部　無線技術部

APPROVED 品証承認	DES.REVIEW 設計承認	CHECKED 確認	DESIGNED 担当
Oct. 20. 2005	Oct. 18. 2005	Oct. 18. 2005	Oct. 18 2005
M. Yoneki	M. Takagi	N. Sugita	Y. Murakami

Control No.	Control name	APPROVED	CHECKER	DRAWN	DESIGNE
HD−SHG− GT02221 (1／2)	Specification report 納入仕様書	Oct.18.2005 M.Takagi	Oct.18.2005 J.Sugita		Oct.18.2005 O. Murakami

(1) Revision history
改訂経歴

Revision No. 改訂経歴	Designed 担当	Rectification record 変更経歴	Checked 確認	Approved 承認
New document 初版	Oct.18.2005 O. Murakami	Newly issued 新規作成	Oct.18.2005 J.Sugita	Oct.18.2005 M.Takagi
A				
B				
C				
D				
E				
F				
G				
H				
J				
K				
L				
M				
N				
P				
Q				

Control No.	Control name	APPROVED	CHECKER	DRAWN	DESIGNE
HD−SHG− GT02221 (2／2)	Specification report 納入仕様書	Oct. 18. 2005 M. Takagi	Oct. 18. 2005 M. Sugita		Oct. 18. 2005 O. Murakami

（2）Document constituent list
構成書類リスト

Control name 書類名	Control No. 書類番号	Document page 構成ページ
General items 一般事項書	HD−AG−A041010−B	1／6 ～ 6／6
Absolute maximum ratings 絶対最大定格書	HD−AM−A021157	1／1
Electrical characteristics 電気的特性書	HD−AE−A021157−D	1／7 ～ 7／7
Electrical characteristics 電気的特性書	HD−AE−B021157	1／1
Electrical characteristics 電気的特性書	HD−AE−C021157	1／2 ～ 2／2
Electrical characteristics 電気的特性書	HD−AE−D041010	1／23～23／23
Outline･Appearance 外形・外観図	HD−AD−A041010	1／3 ～ 3／3
Circuit schematic 内部回路図	HD−MC−B021157	1／1
Pin layout ピンレイアウト図	HD−BA−A021157−A	1／1
Test circuit 検査回路図	HD−AT−A041010	1／1
Instruction for Lot Number ロット番号解説書	HQ−BL−043	1／1
Handling Precaution 取扱注意要領	HQ−BA−506	1／3 ～ 3／3
The Terms of Reliability Tests 信頼性試験条件書	RT5991−004A	1／2 ～ 2／2
Packaging specification 梱包仕様書	HD−BB−A041010	1／2 ～ 2／2

Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD−AG− A041010−B (1／6)	General items 一般事項書	Aug. 23.2005	Aug. 23.2005		Aug. 23.2005

（1）Scope
適用

This specification ("Specification") applies to the hybrid IC "EYMF2CAMM-XV" for use ***Bluetooth***® module ("Product") manufactured by TAIYO YUDEN Co.,Ltd. ("TAIYO YUDEN")
本仕様書は、太陽誘電株式会社("弊社")により製造される ***Bluetooth***®用ハイブリッドIC "EYMF2CAMM-XV" ("本製品")に適用する。

（2）Description
内　容

① Model name：ＥＹＭＦ２ＣＡＭＭ−ＸＶ
型　番　：ＥＹＭＦ２ＣＡＭＭ−ＸＶ

② Function: Radio frequency transceiver Module (power class2, ***Bluetooth***® standard Ver1.1 conformity)
機　能：無線通信モジュール（出力 Class2、***Bluetooth***®　規格 Ver1.1 準拠）

③ Application: PDA, Barcode Reader and Pos
用　途　:PDA, Barcode Reader and Pos

④ Structure: Hybrid IC loaded with silicon monolithic semiconductor
構　造：シリコンモノリシック半導体を用いた混成集積回路

Ability of lead free mounting at customer's assembly (Heat resistance of this Product) :Yes
お客様での Pb フリー実装可否（本製品の耐熱性）　：可能

Containment of hazardous substance in this Product
* RoHS regulation substance(Pb.Cd.Hg.Cr+6.PBB.PBDE) :Non use
本製品内の環境物質含有
* RoHS 規制物質（Pb.Cd.Hg.Cr+6.PBB.PBDE）　：未使用

⑤ Outline　: 34-pin leadless chip carrier
外　形　: 34 ピン　リードレスチップキャリア

⑥ Marking　: Model name, BD_ADDR, Lot No. and manufacturer on Shielding Case
表　示　：シールドケース上に、品名, BD_ADDR, ロット No., 製造会社名を印字

⑦ Notes　:
その他：

a. Limitation of Warranty
保証

i) TAIYO YUDEN provide warranties only if the Product is operated under the condition set forth in this Specification.
Please note that TAIYO YUDEN shall not be liable for any defect and/or malfunction arising from use of the Product under the terms and conditions other than the operating conditions hereof.
本製品の保証使用条件は本仕様書の通りです。
本保証条件以外の条件で御使用になった結果発生した不良・不具合につきましては、弊社は責任を負い兼ねますので御了承下さい。

ii) This Product is designed for use in products which comply with ***Bluetooth***® Specifications (Ver.1.1) ("Bluetooth Specifications"). TAIYO YUDEN disclaims and is not responsible for any liability concerning infringement by this Product under any intellectual property right owned by third party in case the customer uses this Product in any product which does not comply with ***Bluetooth***® Specifications (the "non-complying products"). Furthermore, TAIYO YUDEN warrants only that this Product complies with this Specification and does not grant any other warranty including warranty for application of the non-complying products.
本製品は***Bluetooth***®の規格（Ver.1.1）に従って製造された製品であり、本製品の用途が***Bluetooth***®規格以外もしくは当該規格に従わない製品（「***Bluetooth***®規格外製品」）への使用の場合、弊社は第三者の知的財産権の侵害に基づくいかなる責任を負いません。また、弊社は本製品が本仕様書に準拠することのみを保証するもので、上記***Bluetooth***®規格外製品への応用についての保証等いかなる保証を行うものではありません。

△ iii) In some cases, TAIYO YUDEN may use replacements as component parts of Products. Such replacement shall apply only to component part of Products, which TAIYO YUDEN deems it possible to replace or substitute according to (i) Scope of Warranty provided in this specification (e.g. Electric Characteristics, Outline, dimension, Conditions of Use, Reliability Tests, Official Standard (Type Approvals, Bluetooth LOGO etc.)) and (ii) Quality of Products. TAIYO YUDEN also ensures traceability of such replacement on production lot basis.
本製品を構成する部材の一部について、代替品を使用する場合があります。代替使用は、本仕様書に記載された保証範囲（特性、外形、使用条件、信頼性、公的規格（電波法、Bluetooth LOGO 認証等））、および品質に照らし、弊社にて代替（完全な置換え）が可能と判断致しました Bluetooth IC 以外の部材を対象とさせて頂きます。
尚、使用した部材種についての追跡性は製造ロット毎に確保されます。

b. Instruction for Use (CAUTION)
使用上の注意事項

i) Because Product is not designed for radiation durability, please refrain from exposing Product to radiation in the use.
本製品は、耐放射線設計をしておりませんので、放射線のストレスを受ける環境下での使用は避けて下さい。

ii) Communication between this Product and other might not be established nor maintained depending upon radio environment or operating condition of this Product and other products with ***Bluetooth***® wireless technology.
本製品と本製品又は他製品の通信は、周囲の電波環境及び機器環境により確立又は維持し難くなることがあります。

iii) This Product operates in the unlicensed ISM band at 2.4GHz. In case this Product is used around the other wireless devices which operate in same frequency band of this Product, there is a possibility that interference occurs between this Product and such other devices. If such interference occurs, please stop the operation of other devices or relocate this Product before using this Product or do not use this Product around the other wireless devices.
本製品は 2.4GHz 帯の周波数を使用しています。本製品を本製品と同じ周波数を使用した他の無線機器の周辺でご使用になりますと、本製品とかかる他の無線機器との間で電波干渉が発生する可能性があります。電波干渉が発生した場合、他の無線機器を停止するか、本製品の使用場所を変えるなど電波干渉の生じない環境でご使用下さい。

iv) This Product mentioned in this Specification is manufactured for PDA, Barcode Reader and Pos. Before using this product in any special equipment (such as medical equipment, space equipment, air craft, disaster prevention equipment), where higher safety and reliability are duly required, the applicability suitability, or fitness for particular purpose of this Product must be fully evaluated by the customer at its sole risk to ensure correct and safety operation of those special equipments. Also, evaluation of the safety function of this Product even for use in general electronics equipment shall be thoroughly made and when necessary, a protective circuit shall be added in design stage, all at the customer's sole risk.

本仕様書に記載されている本製品は、PDA、Barcode Reader、Pos 向けとして製造されております。従って、高度の安全性や信頼性が求められる医療用機器、宇宙用機器、あるいは防災機器等にお使いになるときには、本製品の適用可能性、相応性、特定目的に対する適合性をお客様の独自の責任で十分に評価、検討され、御判断下さい。

又、一般機器において御使用になる場合にも、お客様の独自の責任で十分な安全性評価を実施され、必要に応じて設計時に保護回路等を追加してください。

c. Term of Support

サポート条件

i) Customer are requested to fully check and confirm by the start of mass production of this Product that (1)no bug, defect or other failure is included in firmware incorporated in this Product ("Incorporated Software") ,(2)no bug, defect or other failure arising from installation of this Product in which is contained Incorporated Software into customer's products is included in Incorporated Software, and that Incorporated Software fully meets customer's intended use, although TAIYO YUDEN sufficiently inspects or verifies quality of Incorporated Software. TAIYO YUDEN warrants that TAIYO YUDEN uses Incorporated Software which customer have inspected or verified and which customer and TAIYO YUDEN have agreed to incorporate in this Product.

弊社では、本製品に内蔵されているファームウェア（"内蔵ファームウェア"）について十分な品質評価・検証を行っておりますが、お客様におかれましても本製品の量産開始前までに、内蔵ファームウェアに瑕疵やその他品質上の不具合、お客様の製品への組み込み上の不具合がない事を十分に評価され、お客様での本製品の使用用途に合致するものであることをご確認頂けますようお願い申し上げます。弊社は、お客様において品質上の評価・検証がなされ、本製品に内蔵することについてお客様と合意したファームウェアを本製品に内蔵することと致します。

ii) Please note that TAIYO YUDEN is not responsible for any failure arising out of bugs or defects which you have not found in Incorporated Software prior to reaching an agreement of this Specification between customer and TAIYO YUDEN (including the bugs or defects found after customer's acceptance and evaluation), and that TAIYO YUDEN does not render any corrective services, including but not limited to updating or upgrading service for Incorporated Software in case such failures may occur.

納入仕様書の取り交わし前に未検証であったバグ等に起因する不具合（お客様にて評価、承認の上、量産後に発生した不具合）に関しては、弊社の保証範囲外とさせて頂きますので、何卒ご了承ください。また、これらの不具合発生時における内蔵ファームウェアの書換え又はアップグレード等につきましても弊社では対応致しかねますので、予めご了承ください。

iii) In the case that customer requests TAIYO YUIDEN to customize the hardware or software of this Product in order to meet such customer's specific needs, TAIYO YUDEN will make commercially reasonable effort to modify such hardware or software at customer's expense; provide however, the customer is kindly requested to agrees it doesn't mean that TAIYO YUDEN has obligations to do so even in the case it is technically difficult for TAIYO YUDEN.

お客様の都合により、ハードウェアおよびソフトウェアのカスタム対応が必要となった場合、弊社はお客様の依頼により、有償にて本対応を行います。但し、カスタムの内容によりましては、対応できない場合がありますので、予めご了承ください。

iv) Any failure arising out of this Product will be examined by TAIYO YUDEN regardless of before or after mass production. Customer agrees that once such failure is turned out not to be responsible for TAIYO YUDEN after aforesaid examination, some of the technical support shall be conducted by TAIYO YUDEN at customer's expense; provided however, exact cost of this technical support can be agreed through the negotiation by the parties.
お客様にて、量産適用前後を問わず、本製品に起因する問題が生じた場合、弊社は問題解決のために要因の検討を行います。この結果、問題の要因が弊社にないことが判明した後のお客様へのサポートにつきましては、一部有償とさせて戴きますので、予めご了承願います。なお、この際のサポート費用につきましては、その都度両社協議の上、定めさせて頂きます。

d. Caution for Export Control
輸出注意事項
This Product may be subject to governmental approvals, consents, licenses, authorizations, declarations, filings, and registrations for export or re-export of the Product, required by *Japanese Foreign Exchange and Foreign Trade Law(including related laws and regulations)* and/or any other country's applicable laws or regulations related to export control.
In case you will export or re-export this Product, you are strongly recommended to check and confirm, before exporting or re-exporting, necessary procedures for export or re-export of this Product which is required by applicable laws and regulations, and if necessary, you have to obtain necessary and appropriate approvals or licenses from governmental authority at your own risk and expense.
本製品は、日本国の「外国為替及び外国貿易法」（関連法令・規則を含む）及び／又は諸外国の輸出管理関連法規に基づく輸出（再輸出を含む）申請、承認又は許可の対象となる場合があります。本製品を輸出（再輸出）する場合には、必ず事前にこれら関連法規が定める手続をご確認頂き、必要な場合には、お客様の責任と費用において、適切な承認・許可をお取りください。

e. Term of Warranty
保証期間
TAIYO YUDEN warrants only that this Product is in conformity with this Specification for one year after purchase and shall in no event give any other warranty.
弊社は納入後一年間、本製品が本仕様書を満足することを保証します。
本仕様に記載のない事項については協議の上解決するものとします。

f. Items of the Specification
仕様書の記載事項
i) Any question arising from the Specification shall be solved in good faith through mutual discussion by the parties hereof.
本仕様書に疑義の生じた場合は、打ち合わせにより解決します。

ii) The language of this "General items" is Japanese and this "General items" shall be interpreted by Japanese Any copies of translation is a reference purpose only and is not binding on both parties hereto.
本一般事項書は、日本語の記載を主文とし、日本語で解釈されるものとする。翻訳による服本はあくまで参照の目的のみであり、両当事者を法的に拘束するものではない。

Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD−AG− A041010−B (5/6)	General items 一般事項書	Aug. 23. 2005 M. Takagi	Aug. 23. 2005 J. Sugita		Aug. 23. 2005 O. Murakami

Safety Precautions

RE:The use of Embedded Software and customer support
内蔵ソフトウェアの使用とサポートについて

Before using ***Bluetooth***® product.
ご使用にあたって
Please kindly read carefully and understand the following before using the Products.
本製品のご使用にあたっては、以下の事項をご理解頂き、ご了解頂いた上でご使用ください。

1.Taiyo Yuden Co., Ltd. (hereinafter "TY"), lawfully has copyrights and other rights to the software embedded to the memory of the Products (the "Embedded Software"). Except as otherwise expressly provided herein, your company is not permitted to disclose or offer the Embedded Software, either wholly or partly, to any third party (including uploading to your company or third party(ies)'s web sites and downloading by third parties from such sites), nor to copy, revise, reverse engineer, upgrade, make specification change, or alienate the Embedded Software.
太陽誘電株式会社（以下、「弊社」といいます）は、本製品に内蔵された記憶装置に書込まれたソフトウェア（以下、「内蔵ソフトウェア」といいます)に関する著作権その他の権利を適法に有しています。弊社は、内蔵ソフトウェアの全部又は一部を問わず、本製品以外での使用、第三者への開示・提供（Ｗｅｂサイトへの内蔵ソフトウェアの掲載やそこからの第三者によるダウンロード等を含む）及び内蔵ソフトウェアの複製・改変・バージョンアップ・仕様変更、譲渡等（解析調査；Reverse engineering 含む)を禁止させて頂きます。

2. Before using the Products, your company need to check and confirm sufficient safety and operation of your company's products which incorporate the Products and interoperability and compatibility with other ***Bluetooth***® enabled products. By execution or approval of this Specification, your company shall be deemed to have fully evaluated and confirmed the Products (including the Embedded Software) (the Embedded Software that your company has so fully evaluated and confirmed is hereinafter referred to as "Approved Software").
本製品を使用される際には、必ず貴社にて事前に充分な安全性・動作性、他の機器との接続性・適合性等の評価を行い、使用に際し支障が無い事をご確認下さい。本納入仕様書の取り交わしをもって、貴社にて本製品（内蔵ソフトウェア含む）を評価・確認済みであるとみなされます。（貴社にて評価・確認された内蔵ソフトウェアを以下「承認ソフトウェア」といい、その型番等を本仕様書に記載・特定します)。

3. Although TY has made full assessment of the Embedded Software, there is still possibility of malfunction of quality or performance due to the bug or other causes existing in or arising out of the Embedded Software, or due to combination with other product including your product. ("Potential Failure").
Your company shall be deemed to have agreed with the following by the execution or approval of this Specification.
弊社は内蔵ソフトウェアに関して充分な評価を実施しておりますが、内蔵ソフトウェアの Bug その他内蔵ソフトウェアに内在若しくは起因する不具合又は他の機器（貴社製品含む）との組合せによる内蔵ソフトウェアの不具合により、本製品の品質・性能に異常（以下、「潜在的不具合」といいます）が発生する可能性があります。貴社は、潜在的不具合に関し本納入仕様書の取り交わしをもって次の各号に定める事項について合意したものとみなさせて頂きます。

1)The Potential Failure shall not be deemed as defect or failure of the Embedded Software or the Products, under the agreement between TY and your company (executed either in past, or in the future) or under all applicable laws.
潜在的不具合が貴社と弊社との間の契約上（過去・将来を問わない）又は法律上定められた瑕疵又は本製品としての欠陥には該当しないこと。

2)Your company shall indemnify, hold harmless and defend TY from and against any claims, lawsuits, or damages that arise or result from the Potential Failure.
潜在的不具合に起因して貴社に損害が生じた場合であっても、弊社に損害賠償請求その他いかなる請求もしないこと。

4. TY have not evaluated and confirmed the interoperability, compatibility, etc. of the Products (including Embedded Software) with every kind of ***Bluetooth***® enabled product. In addition, TY does not guarantee interoperability and compatibility of the Product with certain devices. In order to minimize the damage or harm arising out of the Potential Failure or out of combination with other devices, TY recommend your company set up interface or external pin (for detail, please refer to Specification "Pin Layout" of this document) for rewriting the Embedded Software.
弊社では、あらゆる機器に対して本製品（内蔵ソフトウェア含む）の動作確認を実施しているわけではありません。また、本仕様書は、本製品において特定の機器への接続性・適合性等を保証するものではありません。内蔵ソフトウェアの潜在的不具合及び各機器との組合せ等により問題が発生した場合にその損害を最小限に止める為にも、本製品を使用する貴社製品に、内蔵ソフトウェアを書き換える為のインターフェイスや外部端子(詳細は本書"ピンレイアウト"を参照)を設けて戴くことを推奨致します。

5. Except as mentioned in Paragraph 2 of "Support limitation when failure occurs" provided below, TY in principal will not accept your company request to update or change the specifications of the Approved Software. In case your company wishes TY to update or change the specifications of Approved Software, or your company do by yourself, please consult TY beforehand.
弊社は、下記「不具合時の対応について」の第２項各号のいずれかに該当する場合を除き、原則として貴社の都合による承認ソフトウェアのバージョンアップや仕様変更のご要望はお引き受け致し兼ねます。貴社のご都合により弊社にバージョンアップ・仕様変更を希望される場合又は貴社においてバージョンアップ・仕様変更等をされる場合は、事前に弊社へご相談ください。

Support limitation when failure occurs.
不具合時の対応について

1.Your company shall take full responsibility at your own expense and cost to resolve whatever kind/form of problem caused by the Potential Failure in the Embedded Software.
本製品に関して、承認ソフトウェアの潜在的不具合により問題が発生した場合、いかなる種類・形態の問題であれ、すべて貴社の責任と費用負担にてご対処頂くものとします。

2.Please kindly notify TY of any Potential Failure. Upon your company's request, TY is ready to provide the following supports.
本製品に関して潜在的不具合が発見された場合には、お手数ですが弊社へご連絡戴けます様、お願い致します。ご連絡頂ければ、弊社は貴社に対して以下のサポートをご提供致します。

1)During one year from the date of the execution or approval of this Specification, TY will provide, free of charge, information or revised/restored Embedded Software then available to TY for resolving problems caused by the Potential Failure.
本仕様書承認後１年間は、本製品の潜在的不具合により発生した問題を解決するために必要な既存情報の提供、改修・修復された内蔵ソフトウェアの提供を無償にて行います。

2)After one year period mentioned above, TY will provide the same supports as mentioned above with chargeto your company. However, in case TY has discontinued manufacturing the Products, TY provides such supports during six (6) months from the discontinuation regardless of whether your company pays relevant costs and expenses.
前号の期間経過後は、有償にて前号の対応を行います。但し、本製品が生産終了となった場合は、有償といえども本号のサポートは当該生産終了後６ヶ月間までとさせて頂きます。

Control No.	Control name	APPROVED	CHECKD	DRAWN	DESIGNED
HD－AM－ A０２１１５７ （1／1）	Absolute maximum ratings 絶対最大定格書	Apr1763	Apr.17.2003 T.Ohmura		Apr.17.2003 T.Yasuda

1．Maximum rating

Item	Symbol	Rating				Remark
		Min.	Typ.	Max.	Unit	
Supply voltage	VDD_MEM, VDD_PIO	-0.3		3.6	V	
Supply voltage	VDD_1.8	-0.3		1.9	V	

2．Recommendation operating range

Item	Symbol	Rating				Remark
		Min.	Typ.	Max.	Unit	
Supply voltage 1	VDD_MEM	3.0	3.3	3.6	V	
Supply voltage 2	VDD_PIO	3.0	3.3	3.6	V	
Supply voltage 3	VDD_1.8	1.75	1.8	1.9	V	
Supply voltage ripple and spike noise	VDD_rn			30	mVp-p	Note 1
Operation temperature range	Topr	0	25	70	Degree C	Humidity=40%RH Note 2

Notes:

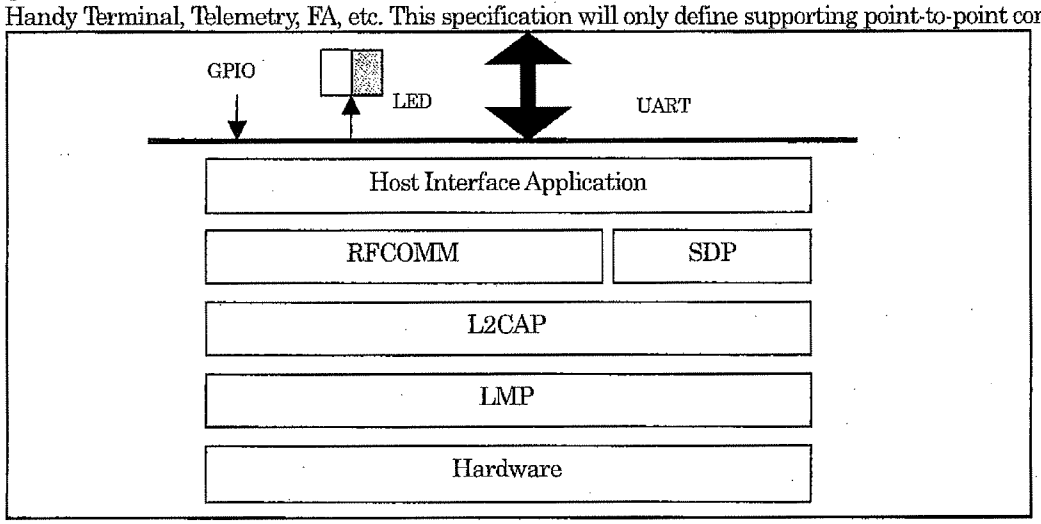
1. In case a regulator of Ripple extraction coefficient (**more than 70dB**) is added to outside of the VDD_1.8 terminal.
2. Operation temperature range is set to satisfy products electrical characteristics for a short period of time. Refer reliability condition to check the product life cycle if you use this module for a long period of time in the condition other than the Typ. standard.

Firmware Version:

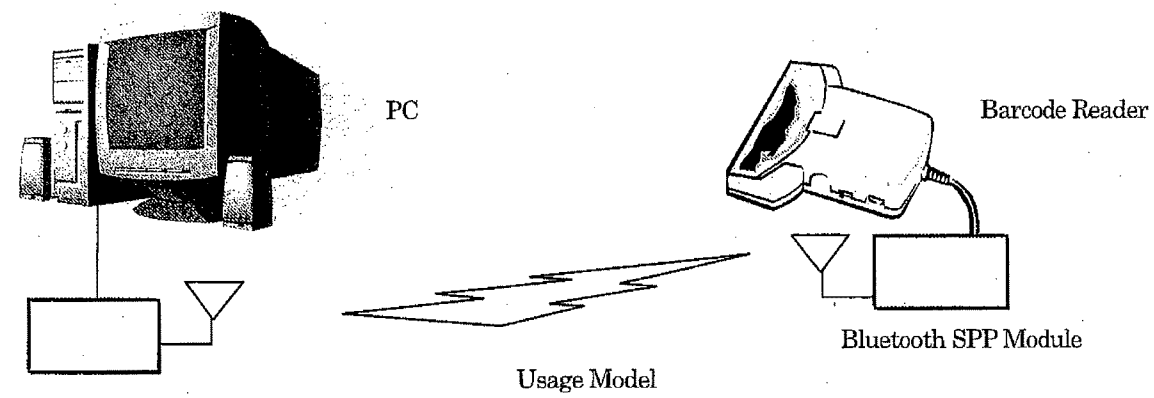
Firmware Version is 1.0.3.0

1. Overview

This specification is for simple cable replacement module based on Serial Port Profile (SPP). Target applications are POS, Handy Terminal, Telemetry, FA, etc. This specification will only define supporting point-to-point connections.



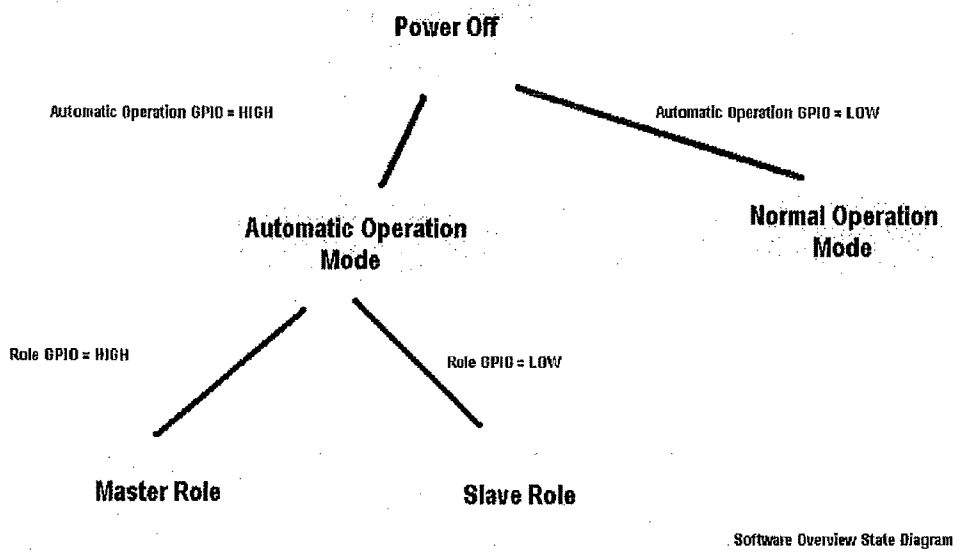
Software Block Diagram



Usage Model

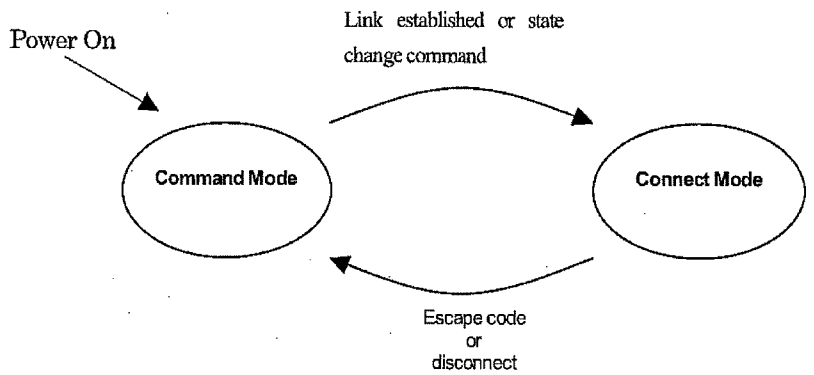
2. Basic software state diagram

Overview Tree:



Software Overview State Diagram

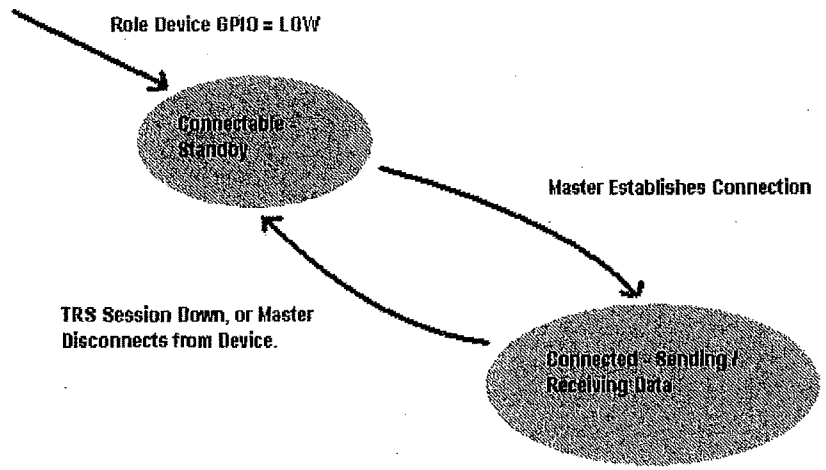
Normal Operation Mode:



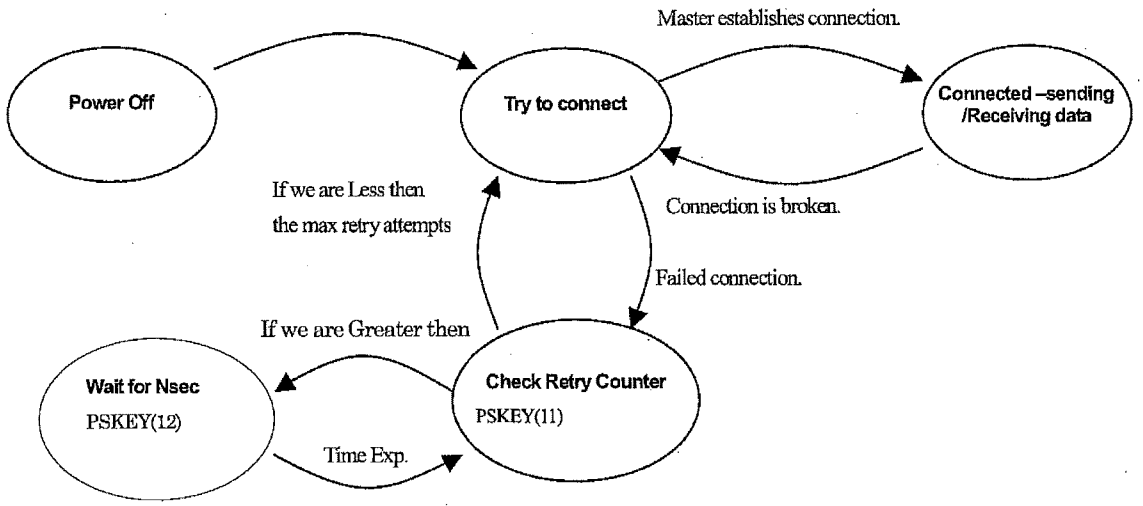
- Command mode:
  Module can only accept control commands in this mode.
- Connect mode:
  In this mode, module can not accept control commands and will transparently send and receive data. When module gets escape command, it will exit this mode and return to Connect Mode.

Automatic Operation Mode:

Slave Role



Master Role Role Device GPIO = HIGH



3. Control Command Syntax

Control commands which the host sends are based on character strings that start with "B"(ASCII code: 0x42, 66 decimal), and that end with <CR><LF> (ASCII code: 0x0D 0x0A) (decimal values 13, 10).
Response event which host receives are started with <CR><LF> and ended <CR><LF>. Please note that this specification / application does not allow for multiple commands to be sent to the host. The application is not responsible for parsing of packets / command sequences.

- Connect Mode – Control Command.
  {command characters} *<- Note you do <u>not</u> need to add the "B" or the <CR><LF> to this cmd.*

- Command Mode - Control Command:
  "B"*{command characters}*[*Parameter1Parameter2:: Parameter(N)*]<CR><LF>

- Response Event:
  <CR><LF>*{command characters}*[*Parameter1Parameter2:: Parameter(N)*]<CR><LF>

4. Command List

4.1 Control Commands

Command Character	Function	Parameter	Response
Mode Control			
+++	Escape (Move to Command Mode only available in Connect Mode)  The period from last command to first character of escape code should be longer than guard time. And the period from end character of escape code to next command should be longer than Guard time. Default value is 50msec. If the periods are shorter than Guard time, escape code is ignored. There is NO DELAY between '+'s. these must go in as a string. ** Note this is the only CONNECT MODE command, and is hence sent without the "B" and <CR><LF>.*		Successful: ACK Failed: *There will be no response as the data will have been sent to the other chipset.*
CM	Move to Connect Mode only available in link established and Command Mode.		Successful: ACK Failed: NAK##
Link Control			
EA	Enable / Disable Authentication / Encryption – This requires Pairing to have taken place before a connection can be made. *Note that the initial value is '0' on Power Up.	Parameter 0 Flag '0' – Disable both Authentication and Encryption '1' – Enable Encryption '2' – Enable Authentication '3' – Enable both Encryption and. Authentication	Successful: ACK Failed: NAK##
CD	Connectable & Discoverable	Parameter 1 Connectable / Discoverable flag '0' – Not Connectable or Discoverable. '1' – Discoverable but not connectable. '2' – Connectable but not Discoverable '3' – Both Connectable and Discoverable	Successful: ACK Failed: NAK##
CO	Connect	BD_ADDR (ASCII)	Successful: CON Failed: NAK##

DC	Disconnect		Successful: DCO Failed: NAK##
SD	Search devices This command is supported specific device searching using Major class ID. Class ID '0'----All Devices Class ID '1'----Computer Class ID '2'----Phone Class ID '3'----LAN/Network Access Point Class ID '4'----Peripheral Class ID '5'----Imaging Class ID '6'----Uncategorized *Note: The SD command will generate a DL event for Each device found up to the amount specified in MAX VALUE. Upon reaching either the Inquiry Timeout (30 Seconds), or the MAX value the Inquiry will inform the host of a successful completion by generating ACK.*	Parameter1 Max Value (['1'::'9']) Parameter2 Major Class ID	Successful: DL, ACK Failed: NAK##
PA	Pairing	BD_ADDR (ASCII)	Successful: PS Failed: NAK##
PE	Pairing Enable - *This enables pairing for 2 minutes. If the device is not paired it will respond with a NAK02 (Pair Timeout). In this case the command must be sent again.*		Successful: ACK Failed: NAK##
RT	Reset the Chip – *This command may take up to five seconds to accomplish*		Successful: Resets Failed: NAK##
Configuration			
ST1	Write remote BD_ADDR (For Auto Connect Mode)	BD_ADDR (ASCII)	Successful: ACK Failed: NAK##
ST2	Write Pin code – (MAX 8 CHARACTERS)	PIN_CODE (ASCII)	Successful: ACK Failed: NAK##
ST3	Set Local Device Name (MAX 248 CHARACTERS) Please Note that CR LF inside the name will cause the name to be truncated at the location.	LOCAL_NAME(ASCII)	Successful: ACK Failed: NAK##
ST4	Set Session Baud Rate '1'= VM_UART_RATE_9K6 '2'= VM_UART_RATE_19K2 '3'= VM_UART_RATE_38K4 '4'= VM_UART_RATE_57K6 '5'= VM_UART_RATE_115K2 '6'= VM_UART_RATE_230K4 '7'= VM_UART_RATE_460K8 '8'= VM_UART_RATE_921K6	BAUDRATE (['1'..'8'])	Successful: ACK Failed: NAK

ST5	Set PSKEY (Note Values 4 > are valid) Example BST5090100 (set PSKEY 9 to 0x0100) The reset is necessary, to do the value enable.	Parameter 0: PSKEY: DD (Decimal value) Parameter 1: Value: HHHH (Hex Word)	Successful: ACK Failed: NAK##
GT1	Read remote BD_ADDR		Successful: BD_ADDR Failed: NAK##
GT2	Read Pin Code		Successful: PIN_CODE Failed: NAK##
GT3	Real Local BD Address		Success: Local BD_ADDR Failed: NAK##
GT4	Read Local Device Name		Success: Local Device Name Failed: NAK##
GT5	Read PSKEY Value (NOTE: values 4 > are valid) Example: BGT507 (Get PSKEY 7)	Parameter 0: PSKEY: DD (Decimal)	Success: Val HHHH Failed: NAK##

4.2 Response Events

Response Events	Function	Parameters
ACK	Successful	
NAK##	Failed	Failed Reason – See Error Section (#11) for further details.
CON	Connection successful	Established BD_ADDR (ASCII)
DCO	Disconnect	
DL	List of Inquiry results	BD_ADDR1 (ASCII)
PS	Pairing successful	
GCMD	Got the Command (PSKEY 15)	
COD	Class of Device – (PSKEY 16)	COD (HEX) Length Unknown
RN	Remote Name – (PSKEY 17)	Name (ASCII) Length Unknown

4.3 Persistent Store (PS) User Key Description

All Values for Defaults are in HEX notation.

Name	PSKEY_USER0	Hex Value:	0x028A	Key Length:	4
Descriptive Name:	Remote BD ADDR				
Description:	Stores the Remote Bluetooth Address for the Automatic Connection sequence.				
Default:	0000 0000 0000 0000				

Name	PSKEY_USER1	Hex Value:	0x028B	Key Length:	16
Descriptive Name:	Link Key				
Description:	Stores the Link key for paired devices. This is used in the Authentication and Encryption process				
Default:	0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000				

Name	PSKEY_USER2	Hex Value:	0x028C	Key Length:	1
Descriptive Name:	Pin Code Length				
Description:	Stores the length of the pin code. This value is a decimal value.				
Default:	0004				

Name	PSKEY_USER3	Hex Value:	0x028D	Key Length:	8
Descriptive Name:	Pin Code				
Description:	Stores the Pin Code. The value for the pin must be ASCII characters. The default is the pin "1234"				
Default:	0031 0032 0033 0034				

Name	PSKEY_USER4	Hex Value:	0x028E	Key Length:	1
Descriptive Name:	Local Class of Device				
Description:	This stores the Local Class of Device ID. If this value is set to zero the IC will default to an unclassified device. Please look at the Bluetooth Assigned numbers to set this value.				
Default:	0000				

Name	PSKEY_USER5	Hex Value:	0x028F	Key Length:	1
Descriptive Name:	Sniff, Max Interval				
Description:	Stores the maximum sniff interval. Please refer to the HCI_ENTER_SNIFF_MODE command for an understanding of this parameter.				
Default:	0000				

Name	PSKEY_USER6	Hex Value:	0x0290	Key Length:	1
Descriptive Name:	Sniff, Min Interval				
Description:	Stores the minimum sniff interval. Please refer to the HCI_ENTER_SNIFF_MODE command for an understanding of this parameter.				
Default:	0000				

Name	PSKEY_USER7	Hex Value:	0x0291	Key Length:	1
Descriptive Name:	Sniff, Attempts				
Description:	Stores the sniff attempts parameter. Please refer to the HCI_ENTER_SNIFF_MODE command for an understanding of this parameter.				
Default:	0000				

Name	PSKEY_USER8	Hex Value:	0x0292	Key Length:	1
Descriptive Name:	Sniff, Timeout				
Description:	Stores the sniff timeout parameter. Please refer to the HCI_ENTER_SNIFF_MODE command for an understanding of this parameter.				
Default:	0000				

Name	PSKEY_USER9	Hex Value:	0x0293	Key Length:	1
Descriptive Name:	Link Supervision Timeout				
Description:	This controls the amount of time before a disconnect will occur on both the master and the slave side. The value in this parameter is multiplied by .625mSec to arrive at the total supervision time.				
Default:	1F40				

Name	PSKEY_USER10	Hex Value:	0x0294	Key Length:	1
Descriptive Name:	Not use				
Description:	This value must be 0000				
Default:	0000				

Name	PSKEY_USER11	Hex Value:	0x0295	Key Length:	1
Descriptive Name:	Automatic Mode Retry Connection Counter Max				
Description:	Stores the Maximum amount of time the master will try to reconnect before going idle for a defined amount of time (see PSKEY_USER12).				
Default:	0003				

Name	PSKEY_USER12	Hex Value:	0x0296	Key Length:	1
Descriptive Name:	Automatic Mode Retry Connection Idle Timer				
Description:	Stores the amount of time the master will be idle before restarting the connection sequence. This value represents the time in seconds.				
Default:	001E				

Name	PSKEY_USER13	Hex Value:	0x0297	Key Length:	1
Descriptive Name:	Uart Stop Bit				
Description:	Stores the parameter used when the UART is configured in Automatic Mode and when using ST4 command. 0 represents One Bit, while 1 represents Two Bit				
Default:	0000				

Name	PSKEY_USER14	Hex Value:	0x0298	Key Length:	1
Descriptive Name:	Uart Parity Setting				
Description:	Stores the parameter used when the UART is configure in Automatic Mode and when using ST4 command. 0 represents NONE, 1 represents ODD, 2 represents EVEN				
Default:	0000				

Name	PSKEY_USER15	Hex Value:	0x0299	Key Length:	1
Descriptive Name:	Enable GCMD response				
Description:	This key enables the GCMD command to be returned when a command is sent into the chipset. This is a useful command when Deep Sleep is enabled to ensure data is being sent and recognized. 0 represents Disabled, 1 represents Enabled, all other values equate to Disabled.				
Default:	0000				

Name	PSKEY_USER16	Hex Value:	0x029A	Key Length:	1
Descriptive Name:	Inquiry Return Class of Device				
Description:	This will enable the Class of Device to be returned after the Inquiry string. 0 represents Disabled, 1 represents Enabled, all other values equate to Disabled.				
Default:	0000				

Name	PSKEY_USER17	Hex Value:	0x029B	Key Length:	1
Descriptive Name:	Inquiry Return Remote Name				
Description:	This will enable the Remote Name to be returned after the Inquiry string (also after the Class of device (see PSKEY_USER16)). 0 represents Disabled, 1 represents Enabled, all other values equate to Disabled.				
Default:	0000				

Name	PSKEY_USER18	Hex Value:	0x029C	Key Length:	1
Descriptive Name:	Authentication / Encryption Default Value				
Description:	This will default the required security for the link. This acts the same as the EA command, but allows devices that use automatic mode the option of requiring pairing for communication. This will be the default security setting in command mode as well.				
Default:	0000				

Name	PSKEY_USER19	Hex Value:	0x029D	Key Length:	1
Descriptive Name:	Not use				
Description:	This value must be 0000				
Default:	0000				

Name	PSKEY_USER20	Hex Value:	0x029E	Key Length:	1
Descriptive Name:	Park, Becaon MAX Interval				
Description:	Stores the beacon maximum interval. Please refer to the HCI_ENTER_PARK_MODE command for an understanding of this parameter.				
Default:	0000				

Name	PSKEY_USER21	Hex Value:	0x029F	Key Length:	1
Descriptive Name:	Park, Becaon MIN Interval				
Description:	Stores the beacon minimum interval. Please refer to the HCI_ENTER_PARK_MODE command for an understanding of this parameter.				
Default:	0000				

Name	PSKEY_USER22	Hex Value:	0x02A0	Key Length:	1
Descriptive Name:	LED lighting pattern				
Description:	Stores the LED lighting pattern. Please refer to the "7.0 LED Operation"				
Default:	0000				

Name	PSKEY_USER23	Hex Value:	0x02A1	Key Length:	1
Descriptive Name:	Automatic Pairing Default Value				
Description:	This will enable the pairing mode in Automatic Slave mode. 0 represents Disabled, 1 represents Enabled.				
Default:	0000				

Name	PSKEY_USER24	Hex Value:	0x02A2	Key Length:	1
Descriptive Name:	Recover reconnect				
Description:	This will enable the auto reconnect in Automatic Slave mode. 0 represents Disabled, 1～60 is reconnect time.				
Default:	0000				

Name	PSKEY_USER25	Hex Value:	0x02A3	Key Length:	1
Descriptive Name:	Scan_Window				
Description:	Stores the Page_Scan_Window and Inquiry_Scan_Window. Range: "0012"-"1000"				
Default:	0200				

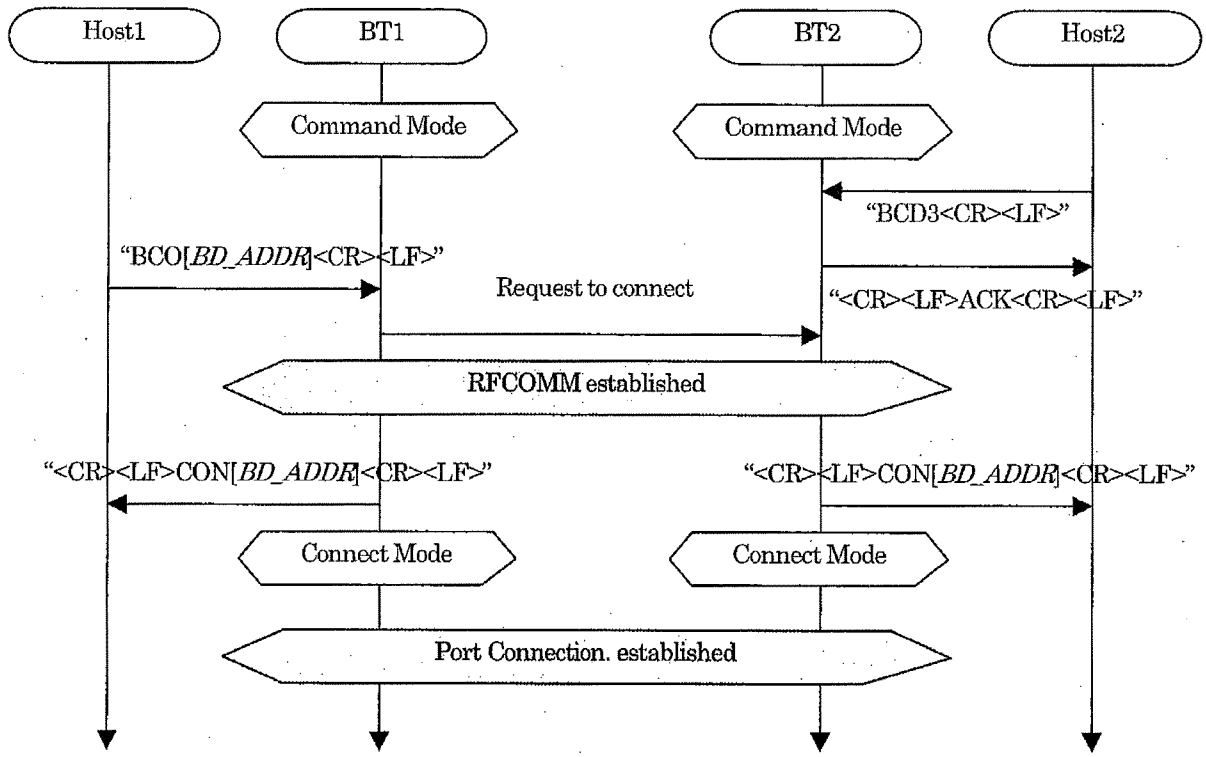
Name	PSKEY_USER26	Hex Value:	0x02A4	Key Length:	1
Descriptive Name:	Scan_Interval				
Description:	Stores the Page_Scan_Interval and Inquiry_Scan_Interval. Range: "0012"-"1000"				
Default:	0400				

Device name

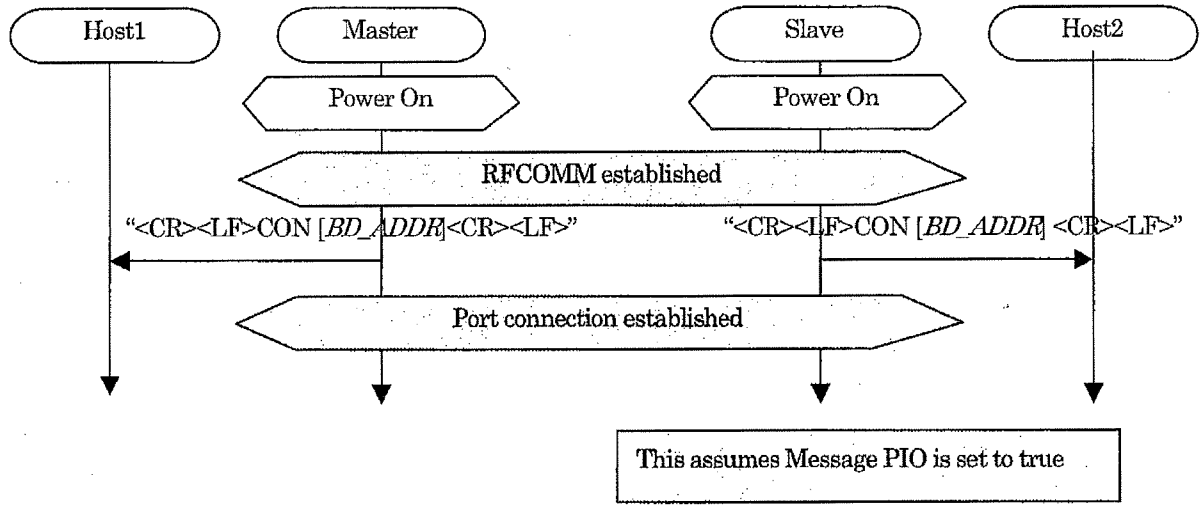
TAIYO SPP

5. Message Sequence Chart

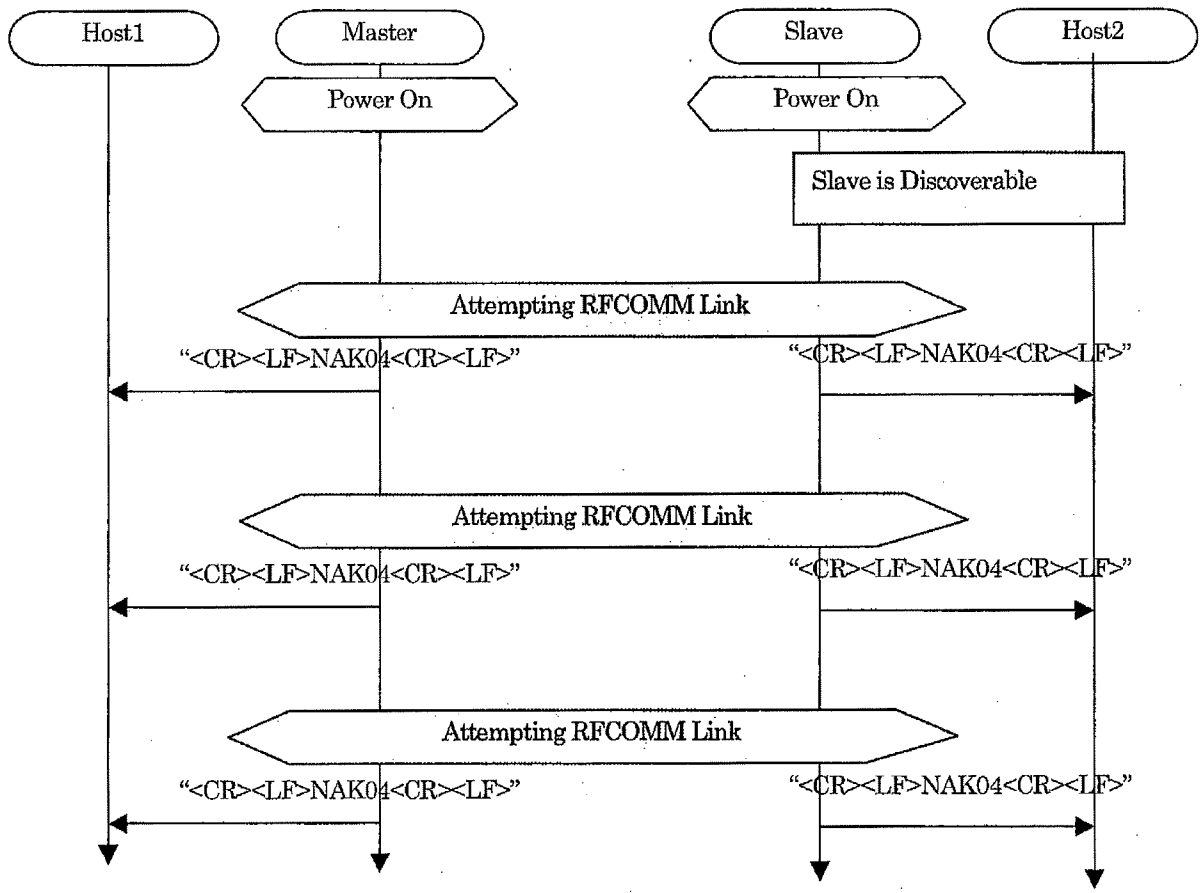
5.1 Connection (Command Control Mode)



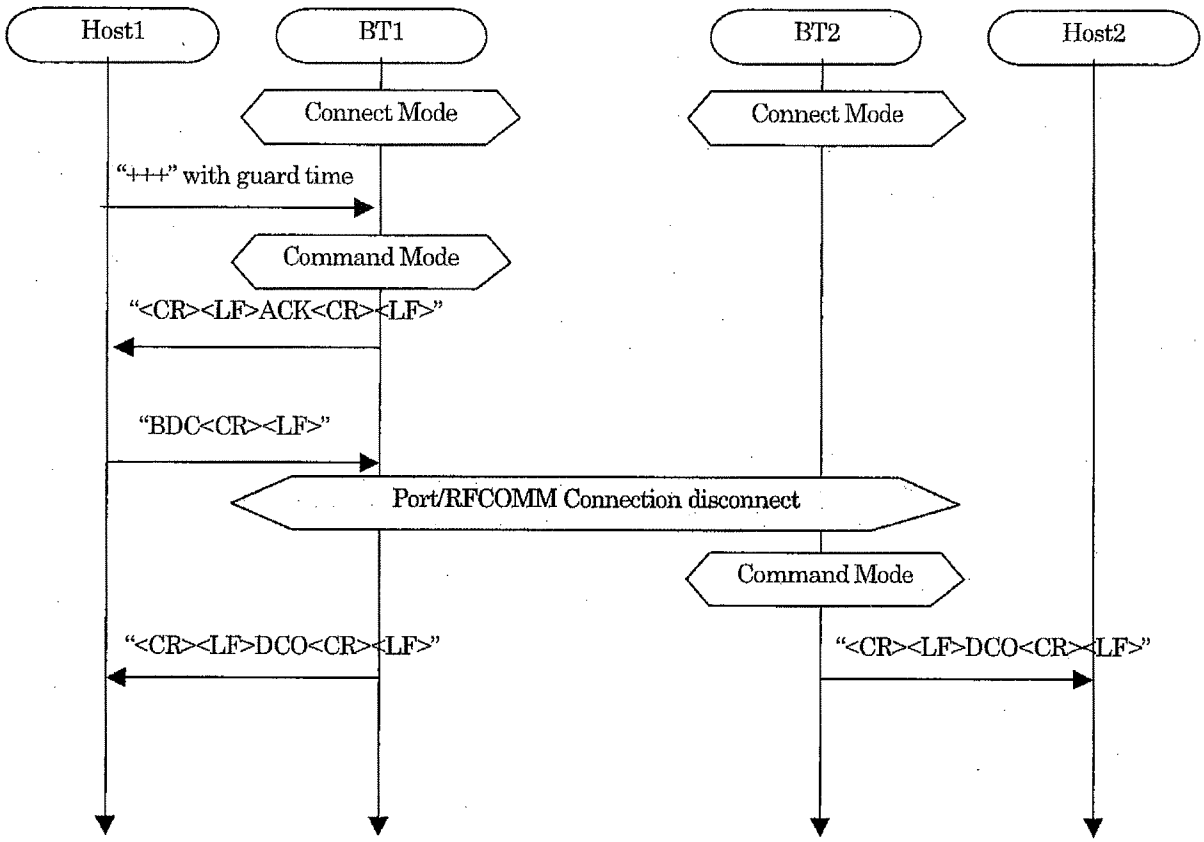
5.2 Connection (Automatic Mode)



5.3 Connection Failed(Automatic Mode)

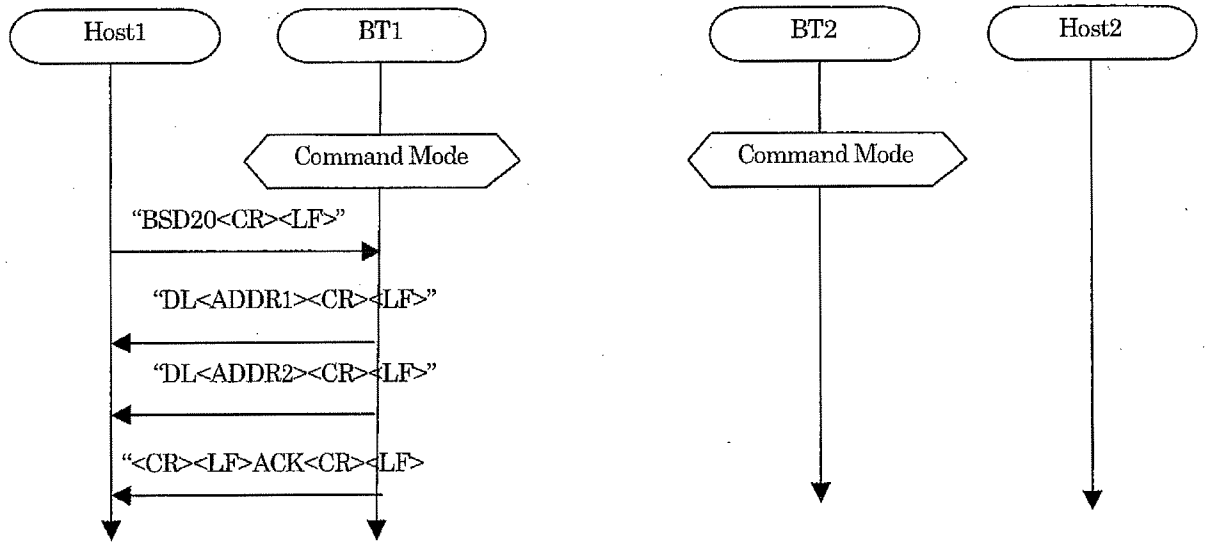


5.4 Disconnect

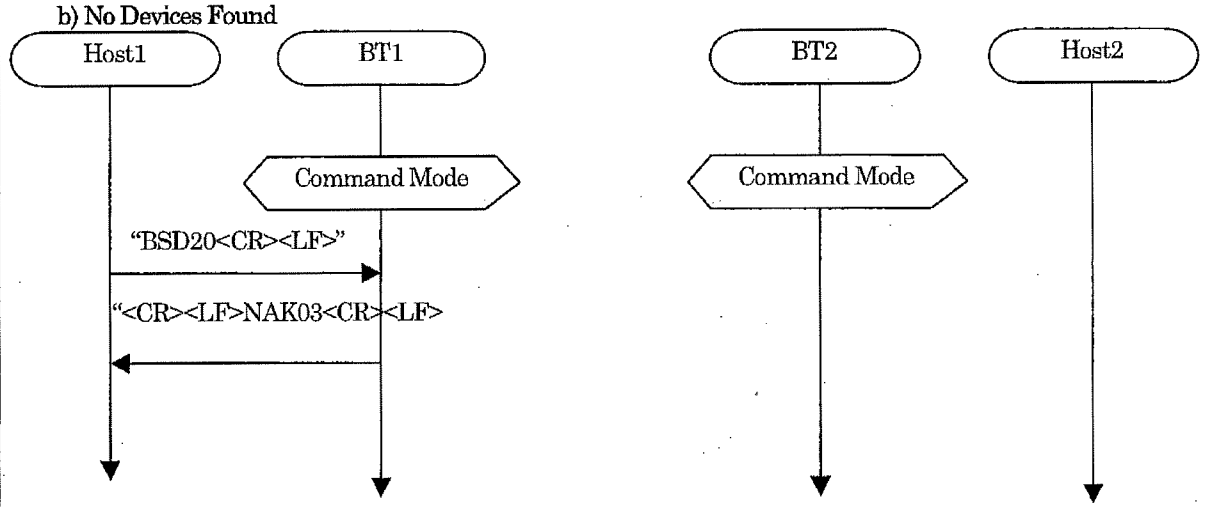


5.5 Search devices (Command Mode)

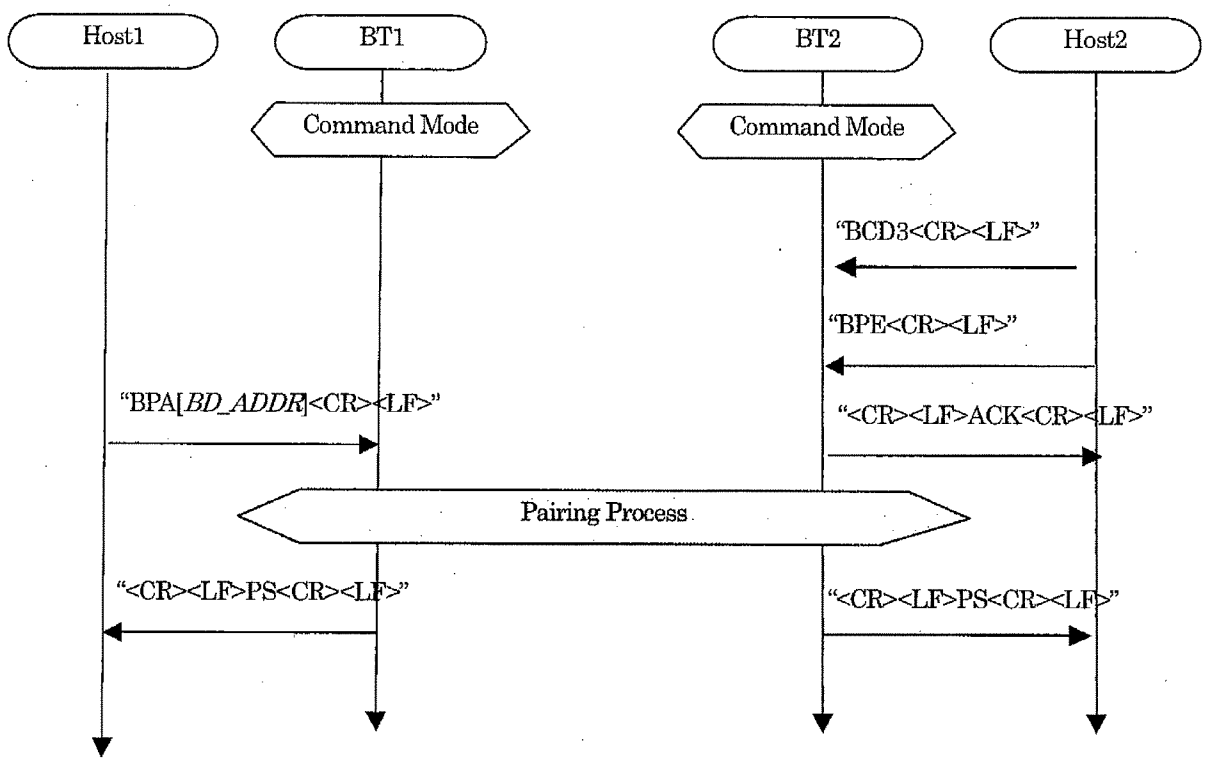
a) Devices Found



b) No Devices Found

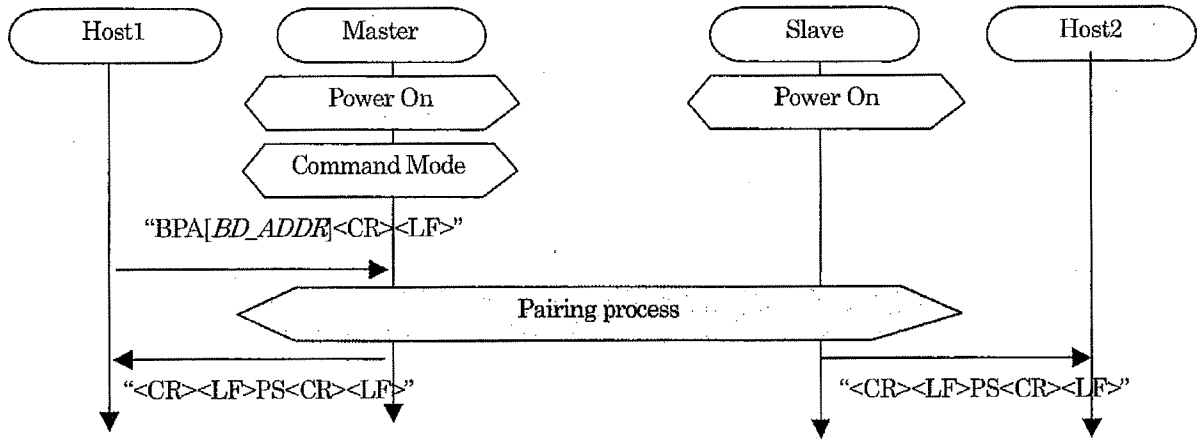


5.6 Pairing (Command Mode)

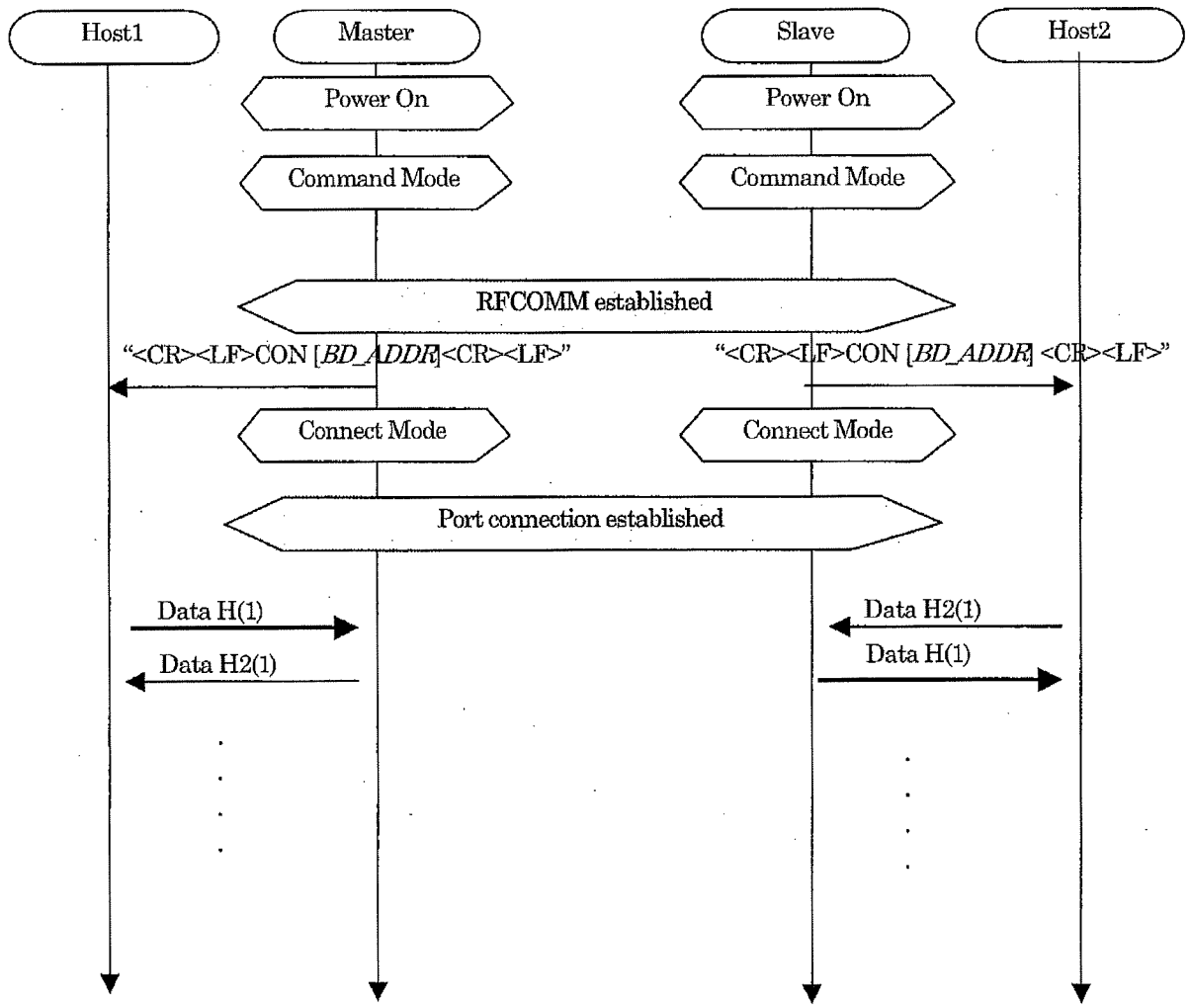


5.7 Pairing (Automatic Mode)

If PSKEY_USER23 is set 0001 becomes Pairing enable. This is the Slave only.



5.8 Sending Data Over a connected Link



6. 0 GPIO Configuration

CSR GPIO Configurations

Chip Pin	Configuration	Function	Descriptions
PIO6	Input	Operation Mode	Switch for Automatic/Command control mode
PIO7	Input	Role	Switch for Master/Slave mode (For Automatic Mode)
PIO3	Output	LED[0]	Light LED0
PIO5	Output	LED[1]	Light LED1
PIO8	Input	Baud Rate[2]	Configure Baud Rate
PIO9	Input	Baud Rate[1]	Configure Baud Rate
PIO10	Input	Baud Rate[0]	Configure Baud Rate
PIO4	Input	Message Enable	This determines if Messages are generated in Automatic Mode

Automatic Mode - Baud Rate Configuration

Baud Rate	Baud Rate[0]	Baud Rate[1]	Baud Rate[2]
9600[bps]	L	L	L
19200[bps]	H	L	L
38400[bps]	L	H	L
57600[bps]	H	H	L
115200[bps]	L	L	H
230400[bps]	H	L	H
460800[bps]	L	H	H
921600[bps]	H	H	H

Role Configuration

Role	Logic
Master	H
Slave	L

Operation Mode

Mode	Logic
Automatic	H
Command Control	L

Message Enable

Mode	Logic
Messages Disabled	H
Messages Enabled	L

7.0 LED Operation

7.1 Pattern 1

In the case that the value of PSKEY_USER22 is "0000".

(A) – Definitions

- **Command Mode**
  - Fast Red and Green Alternating LED – Device is in pairable mode.
  - Red and Green Alternating LED - Device is in a discoverable state.
  - Red blinking LED – Device is in Command Mode
  - Green blinking LED – Device is in Connect Mode
- **Automatic Mode**
  - Red and Green Alternating LED – Device is in a discoverable state
  - Red Blinking LED – Device is not Connected.
  - Green Blinking LED – Device is Connected

(B) – LED Timing Chart

- Fast Alternating LED –

250 250 (msec)

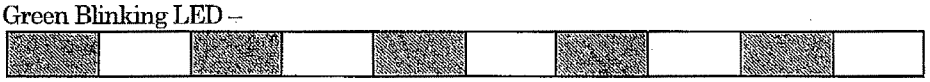
- Alternating LED –

500 500 (msec)

- Red Blinking LED –

200 200 (msec)

- Green Blinking LED –



200 200 (msec)

Red is LED[0] (PIO3)
Green is LED[1] (PIO5)

7.2 Pattern 2

In the case that the value of PSKEY_USER22 is "0001".

(A) – Definitions

- **Command Mode**
  - Slow Green blinking LED – Device is in Connect Mode.
  - Green blinking LED – Device is in Command,Discoverable and Pairable Mode
- **Automatic Mode**
  - Slow Green Blinking LED – Device is Connected.
  - Green Blinking LED – Device is not Connected

(B) – LED Timing Chart

- Slow blinking LED –

100 *2000* *(msec)*

- Blinking LED –

500 *500* *(msec)*

Use LED[1] (PIO5)

Note.
PIO Low is LED ON.
PIO High is LED OFF

8.0 UART Flow Control

CTS/RTS flow control is used in this module. If UART buffer is overflow, RTS is settled to 0. Host detects this signal from CTS of host. After that, host stops to send data. But normally RTS is settled to 1.

9.0 Error Codes

#	Error Name	Program Logic Cause	Action taken by host
-1	Unknown Error	There is the possibility that the hardware is out of order.	Reset Module
0	Command Not Recognized	It confirms whether or not the command is correct.	Send the command once again.
1	Bad Parameter	It confirms whether or not the parameter is correct.	Send the command once again.
2	Pairing Failure	Confirm PIN on both the master and the slave. Make sure the device is connectable and discoverable. Make sure both sides have issues the appropriate pairing command	Repeat the pairing procedure
3	No Inquiry Result	Confirming the condition (the discoverablelity) of other devices. This is not an error per say, but a response letting the host know nothing came back for one reason or another.	Send the command once again.
4	Create Connection Failure	Confirming the condition (the connectable, security) of other devices.	Send the connect command once again
5	Parse Error	It confirms whether or not the PIN code is correct. (MAX value (8)).	Send the command once again.
6	PS KEY Error	There is the possibility that the hardware is out of order. Meaning the Flash memory has been fragmented due to too many writes.	Reset
8	Connect Mode Only Command	Meaning the command issued is not recognized in command mode.	Move to the correct state and issue the command
9	Command only allowed when connected and in command mode	Meaning the command issued is not recognized in command mode when a connection is not present.	Move to the correct state and issue the command
10	Uart Stream Error	There is the possibility that the hardware is out of order, if it occurred once again.	Reset
11	Local Name to Long	The device name length is big than the MAX value (248). It must make to 248 or less.	Resend the command.
12	Command only when connected	This is similar to #9 but represents a different logic state	Move to the correct state and issue the command.
13	PSKey Not Set	It sets up it once again with a/the ST command. There is the possibility that the hardware is out of order, if it occurred once again. (NOTE: make sure all PSKEYS are set correctly)	Reset
14	Command not completed	The issued command did not terminate	Send the command once again.

10.0 Low Power mode

10.1 Sniff mode

Sniff mode is enabled when the following PSKEYs are set to none zero values on both the Master and Slave device. The values as represented by the PSKEYS are the same as those used and defined in the HCI Enter Sniff Mode command.

PSKEY:

USER5	Max Interval
USER6	Min Interval
USER7	Attempts
USER8	Timeout

The data communications are carried out during the sniff mode. Exit sniff is done automatically. Applications are not aware that low power saving modes are being used as it is a transparent sequence.

10.2 Park mode

Park mode is enabled when the following PSKEYs are set to none zero values on both the Master and Slave device. The values as represented by the PSKEYS are the same as those used and defined in the HCI Enter Park Mode command.

PSKEY:

USER20	Beacon Max Interval
USER21	Beacon Min Interval

The data communications are carried out during active times in the ACL link. This is when the devices are not in park mode. When idle devices will be in the low power saving mode. Applications are not aware that low power saving modes are being used as it is a transparent sequence.

The master side does EXIT PARK REQUEST and PARK REQUEST cyclically.

If both Sniff and Park are defined by the host and the slave the low power saving mode will first try to use Sniff and if successful will then move to Park mode where the ultimate power saving can take place.

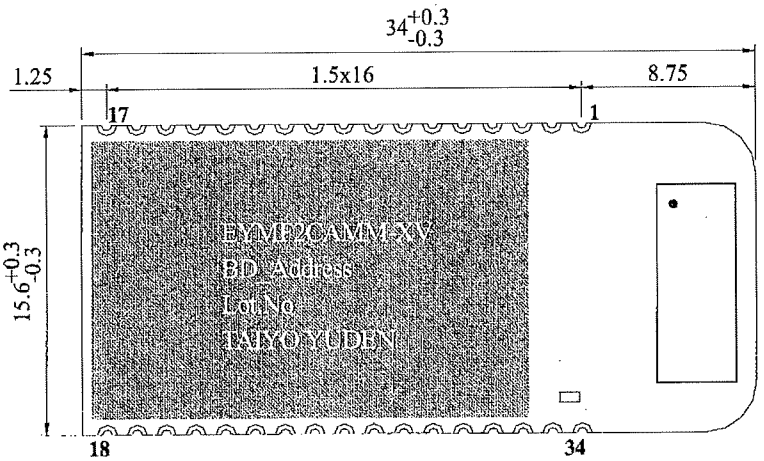
11.0 Known Issues

1. Currently executing the "+++" Escape Sequence during a large transmission will not guarantee moving to the command mode state.
2. The pairing for automatic mode in Master role is not supported.
3. 4800 Baud Rate (and lower) is not supported by CSR
4. Repeated commands that affect PSKEYs will cause the chips memory to Fragment and then reset the chip. This is a known CSR issue.
5. Sending the CD1 command will make the device Discoverable, but on certain timing windows the device will be connectable as well. This is a known CSR feature that allows for quicker connection times.
6. When an address of 0000000000 is recieved in the CON event to please disconnect and then to reconnect to the same device with a Rand() pause in the timing
7. In Automatic Mode (PIO6 = "H") Recover reconnect function will not work correctly when the Link is disconnected if Recover reconnect function is Enable (PSKEY_USER24 is not 0x0000) and Authentication/Encryption function is Enable (PSKEY_USER18 is not 0x0000).
8. If both of Master (the Product) and Slave (the Product) continue to send a large amount of data bi-directionally, once in a long while a phenomenon occurs in which the Device is reset suddenly. This is a known CSR issue. Evaluation of this Product shall be thoroughly made under the actual products' environment including peripheral circuits, control methods, use environment and radio wave environment.
9. LED blinking cycle is infrequently off on a temporary basis.

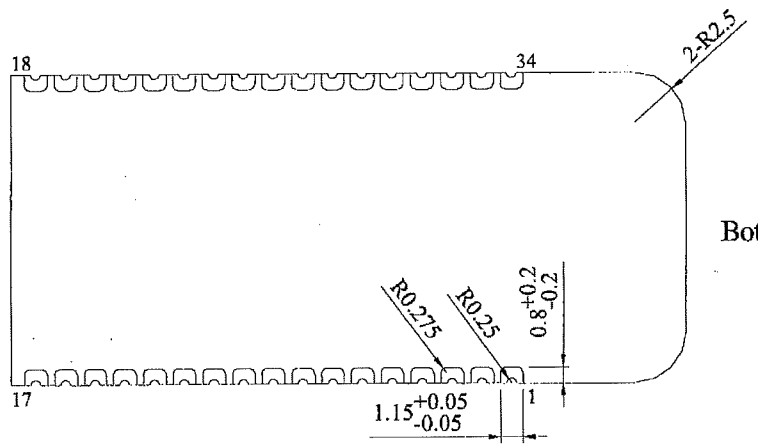
Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD−AD−A041010 (1／3)	Outline・Appearance 外形・外観図	Jun.18.2004	Jun.18.2004		Jun.18.2004

Tolerances unless otherwise specification : +/- 0.2mm
指示無き公差：±0.2mm

Unit : mm



Top View

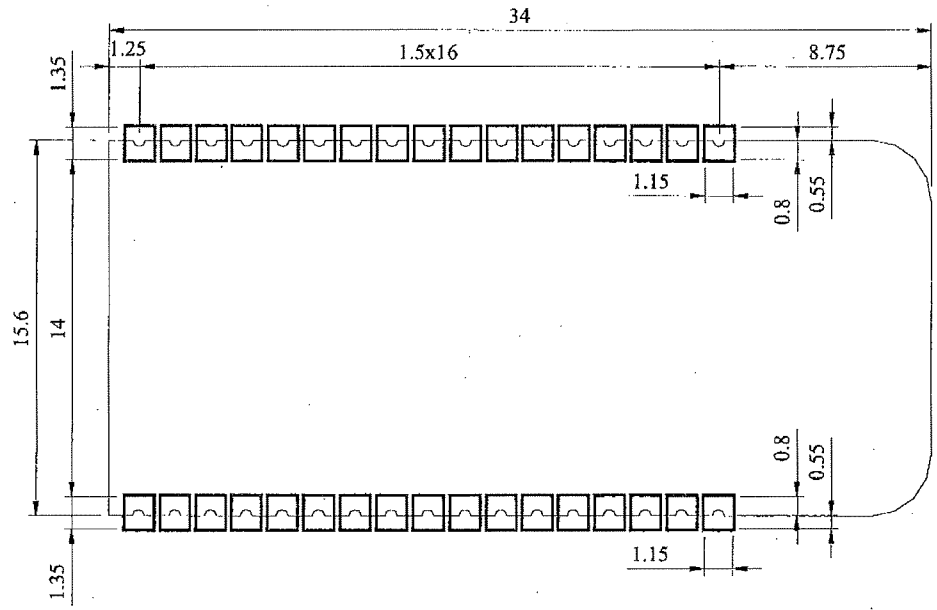


Bottom View

Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD−AD− A041010 (2／3)	Outline・Appearance 外形・外観図	Jun.18.2004	Jun.18.2004		Jun.15.2004

LAND PATTERN EXAMPLE

Unit: mm

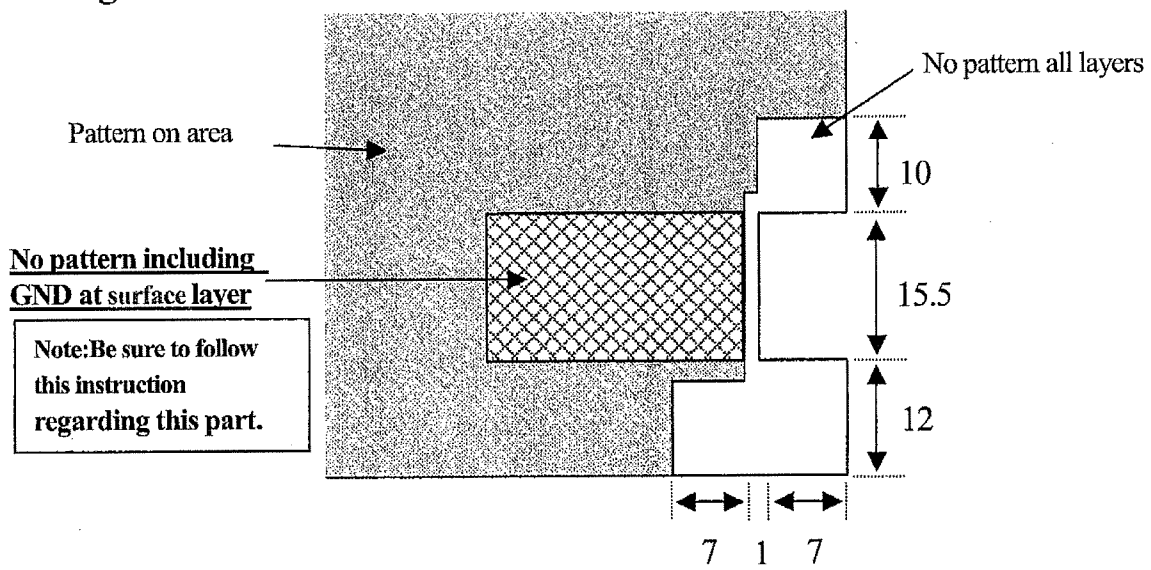


Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD−AD−A041010 (3／3)	Outline･Appearance 外形・外観図	Jan.19.2004	Jan.18.2004		Jan.18.2004

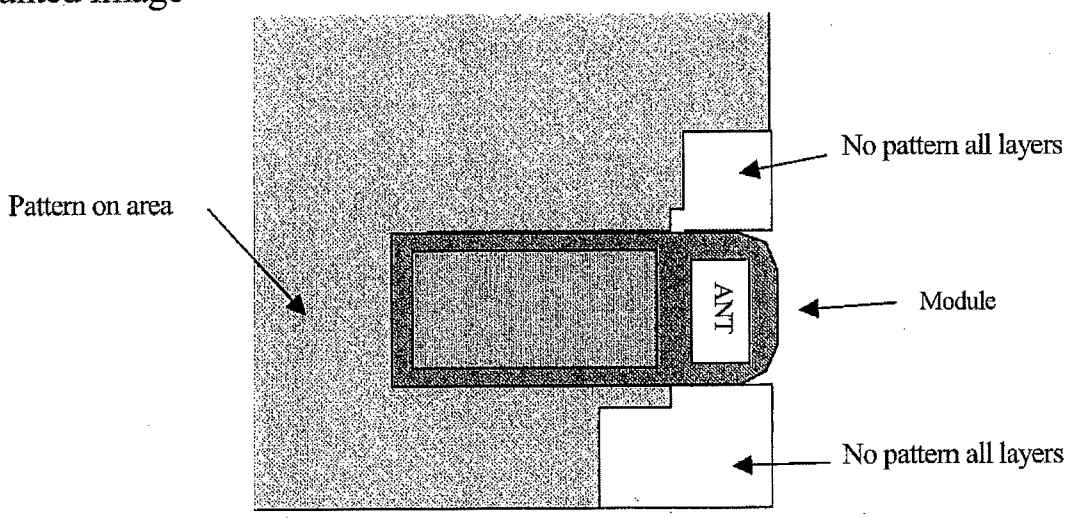
Design example of antenna area (Taiyo Yuden Eva Board)

Unit : mm

1.Design Dimension



2.Mounted Image



*** We recommend the spacing between antenna and case is 1 mm and more.**
Please try to avoid using metal and material contained metal for case material.
We'd like to have additional meeting for this actual use.

Electrical characteristics

DC Specifications

The Specification applies for Topr.=25 degrees C, VDD_MEM= VDD_PIO =3.3V,VDD_1.8=1.8V

No.	Parameter	Condition	Symbol	Min.	Typ.	Max.	Unit	Remark
1	Operating Voltage 1	VDD_MEM= VDD_PIO	VDD_MEM	3.0	3.3	3.6	V	
2	Operating Voltage 2	VDD_MEM= VDD_PIO	VDD_PIO	3.0	3.3	3.6	V	
3	Operating Voltage 3		VDD_1.8	1.75	1.8	1.9	V	
4	Input Low Voltage	UART_CTS, UART_RX, PIO(0)-(11),AIO(0)-(1), RESET	VIL	-0.3	-	0.8	V	Note 1
5	Input High Voltage	UART_CTS, UART_RX, PIO(0)-(11), AIO(0)-(1),RESET	VIH	0.7VDD_PIO	-	VDD_PIO+0.3	V	Note 1
6	Output Low Voltage	UART_RTS, UART_TX, PIO(0)-(11), AIO(0)-(1)	VOL	-	-	0.4	V	Io=4mA
7	Output High Voltage	UART_RTS, UART_TX, PIO(0)-(11), AIO(0)-(1)	VOH	VDD_PIO-0.4	-	-	V	Io=4mA
8	Peak current	Continuous Rx	Iccp1_3.3		17	40	mA	Note4
			Iccp1_1.8		50	80		
9	Average current1	Sniff mode (Slave only)	Icca1_3.3		2		mA	Note 2, 4
			Icca1_1.8		4			
10	Average current2	Standby mode	Icca2_3.3		1		mA	Note4
			Icca2_1.8		2			
11	Average current3	Send data (Master)	Icca3_3.3		10		mA	Note4
			Icca3_1.8		53			
12	Average current4	Receive data (Slave)	Icca4_3.3		10		mA	Note4
			Icca4_1.8		24			
13	Average current5	Park mode (Slave only)	Icca5_3.3		2		mA	Note3,4
			Icca5_1.8		4			

Notes:

1. Please put the series resistance about 1k ohm into the all input signal line(UART, PIO).
   As for the Power up Sequence, please refer the following page from 2/7 to 4/7.
2. Sniff mode parameter.
   Max interval 0100h
   Min interval 0010h
   Attempt 000Ah
   Timeout 0005h
3. Park mode parameter.
   Max interval 0100h
   Min interval 0010h
4. The typical consumption current might fluctuate with the condition of radio communication, host performance and test circuit.

AC Specifications

The Specification applies for Topr.=25 degrees C, VDD_MEM= VDD_PIO =3.3V,VDD_1.8=1.8V

	No.	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
	1	VDD_MEM, VDD_PIO Rise Time from 0V to 3 V		t1			2	ms	Note 1, 2
	2	VDD_1.8 Raise Time form 0V to 1.75V		t2			2	ms	Note 1, 2
	3	VDD_MEM, VDD_PIO 3V to VDD_1.8 1.75V		t3			10	ms	
	4	Power on to stable condition		t4			t3+2	ms	Note 3
	5	RESET Pulse Width		t5	10			ms	Note 4
△	6	RESET Low to Module Ready		t6		(450)	3000	ms	Note 5, 6, 7
	7	VDD_1.8 1.75V to VDD_MEM, VDDPIO 3V		t7			10	ms	
	8	VDD_MEM, VDD_PIO 3V to RESET High		t8	0			ms	Note 4, 8
	9	VDD_1.8 Off to VDD_PIO, VDD_MEM Off		t9			10	ms	
	10	UART_I/F Off to VDD_1.8 Off		t10	0			ms	Note 9
	11	VDD_PIO, VDD_MEM Off to VDD_1.8 Off		t11			10	ms	
	12	UART_I/F Off to VDD_PIO, VDD_MEM Off		t12	0			ms	Note 9
△	13	RESET Low to RESET High		t13	3000			ms	Note6,10
△	14	Module active to RESET High		t14	0			ms	Note 10

Notes:

1. If t1 is not satisfied the rise time, please input RESET signal of 10 ms or more after VDD_PIO, VDD_MEM and VDD_1.8 are in condition of steady state.

△ 2. This module has an internal flash memory and a function to erase/sort unnecessary data if certain commands are issued and consume more than a certain level of free space in the flash memory. This operation occurs at every module initialization (power-on). If supply voltage becomes non-defined states during initialization or writing in flash memory, data in flash memory might be destroyed. If the data in flash memory is de stroyed, module will not work correctly. Therefore please be sure to stabilize power source before RESET release. In addition please design module peripheral circuits to avoid temporary blackout of power source during operation. Please refer HD-AE-D021157 for SPP command which rewrites flash memory data.

△ 3. During t4 input or output is unstable and this condition occurs at the all I/O pins.
This unstable condition of t4 continues until VDD_1.8 reaches its steady state after VDD_PIO and VDD_MEM supply. After that, it takes some time to discharge when the unstable condition of PIO pin and UART pin are output high. Discharged time changes depending on the outside load. Please pull-down PIO pin with a 3k ohm resistor to reduce the discharged time. Please operate by using the Timing Diagram for Power Up Sequence 2 to eliminate the unstable condition.

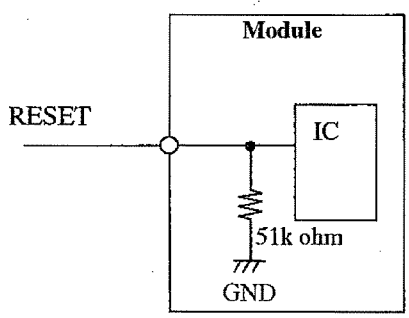
4. Pull-down resistor inside the Module is 51k ohm (Typ.). See the figure below.
5. When the module is ready to accept the command, its module outputs the "Init X.X.X.X (BuildXXX)" to the UART_TX signal. After that, please access to the module. X:Firmware version and Build No.

△ 6. Some of User Settings are stored in flash memory writable memory area and flash memory free space is controlled by Firmware. When the free space in flash memory is lower than certain amount, Defrag automatically starts. Defrag usually starts after RESET release or after the power supply of 1.8V reaches its steady state after power on. After Defrag process module outputs the "Init X.X.X.X (Bui ldXXX)". Amount of time required for Defrag will vary depending on the environment. Please conduct enough verification for the time required for the customer's product under customer's environment before use. Please avoid power OFF and input of RESET during Defrag process.

△ 7. The Typ. is a reference value. The value may change depending on the firmware version, conditions of use and types of flash memory.

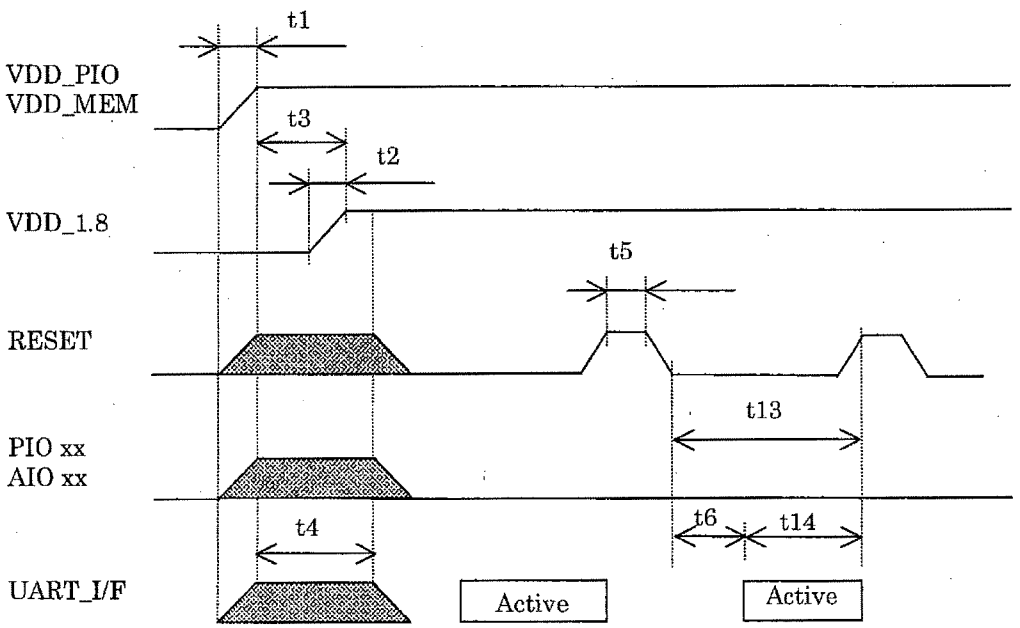
8. Please input RESET signal without fail, if you op erate the module by Timing Diagram for Power Up Sequence 2. In case of Timing Diagram for Power Up Sequence 1, we recommend to input RESET signal.
9. After the end of communication, please set UART_RTS and UART_RX to low before turning the power off.

△ 10. You don't need to wait t13 if you confirm that this module has output "Init X.X.X.X (BuildXXX)".

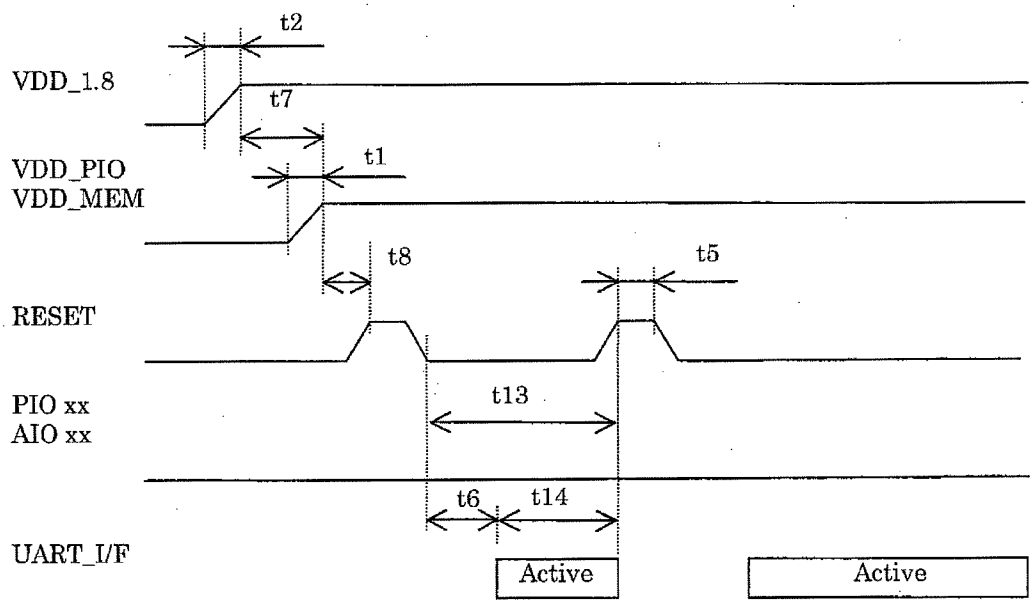


Equivalent Circuit of Internal Reset

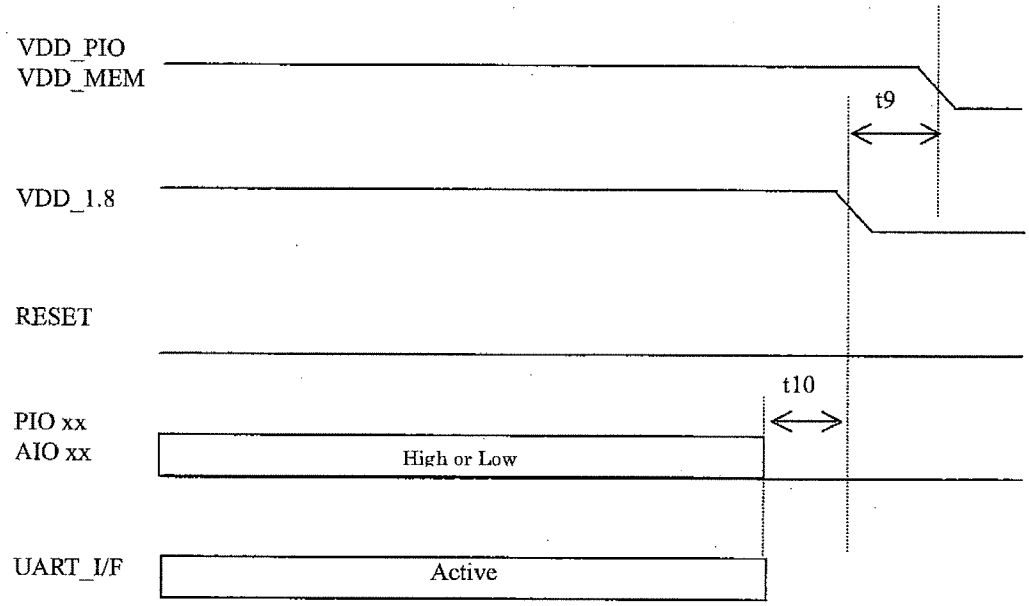
△



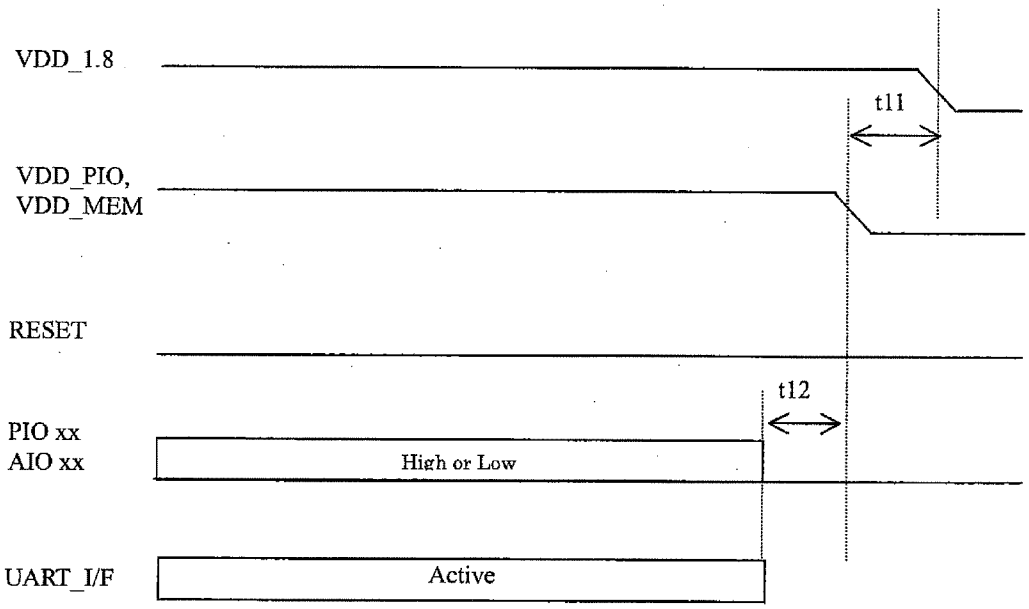
Timing Diagram for Power Up Sequencel



Timing Diagram for Power Up Sequence 2



Timing Diagram for Power Down Sequence 1



Timing Diagram for Power Down Sequence 2

UART Interface

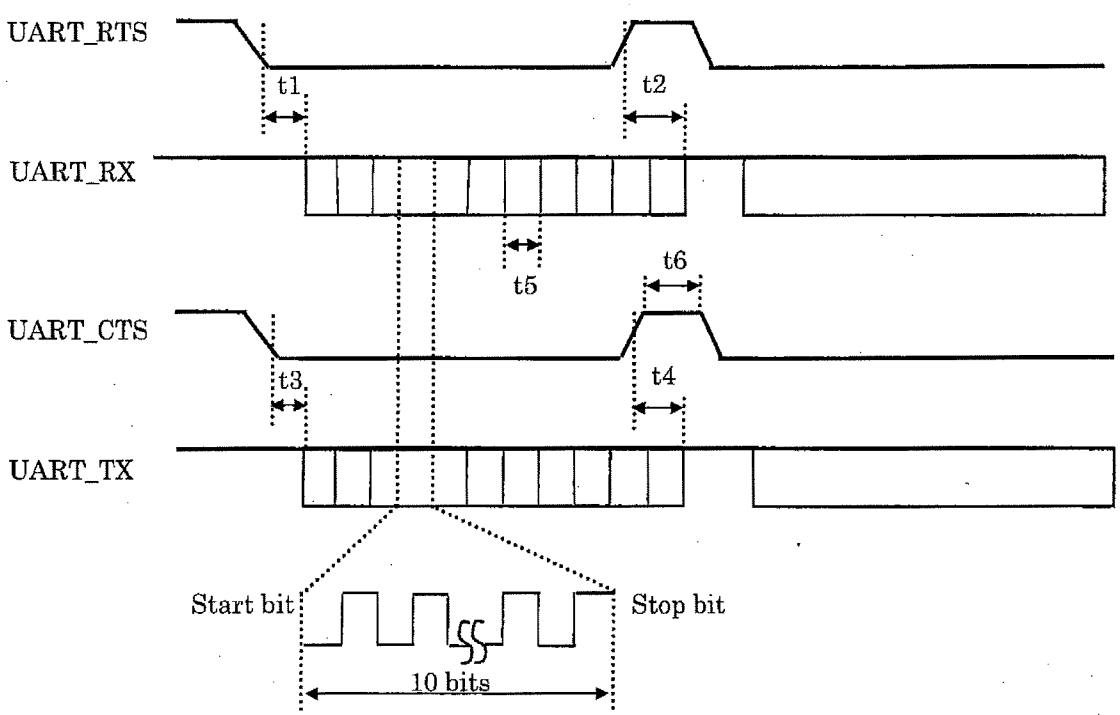
AC Specifications

The Specification applies for Topr.=25 degrees C, VDD_MEM= VDD_PIO =3.3V,VDD_1.8=1.8V

No.	Parameter	Condition	Symbol	Min	Typ	Max	Unit	Remark
1	RTS Low to RX Data On		t1	0			ms	
2	RTS High to RX Data Off		t2			1	byte	
3	CTS Low to TX Data On		t3	0			ms	
4	CTS High to TX Data Off		t4			2	byte	
5	Data 1 Character error (TX)		t5	-2		2	%	Note 1, 2
6	Data 1 Character error (RX)		t5	-2		2	%	Note 1, 3
7	CTS High Pulse Width		t6	4			bit	

Notes:

1. +/- 2% of 10 bit width
2. Simulated value
3. Effective value



Timing Diagram for UART signals

<UART Parameters>

Item	Parameter
Baud Rate	115.2kbps
Date Bits	8bits
Stop Bits	1bit
Parity	None
Flow Control	CTS/RTS

Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD－AE－ B021157 (1／1)	Electrical characteristics 電気的特性書	Apr.17.2003	Apr.17.2003 J.Sugita		Apr.17.2003 H.Yasuda

Electrical characteristics

RF Specifications

The Specification applies for Topr = 0 to 70 degrees C, VDD_MEM=VDD_PIO=3.3V, VDD_1.8=1.8V

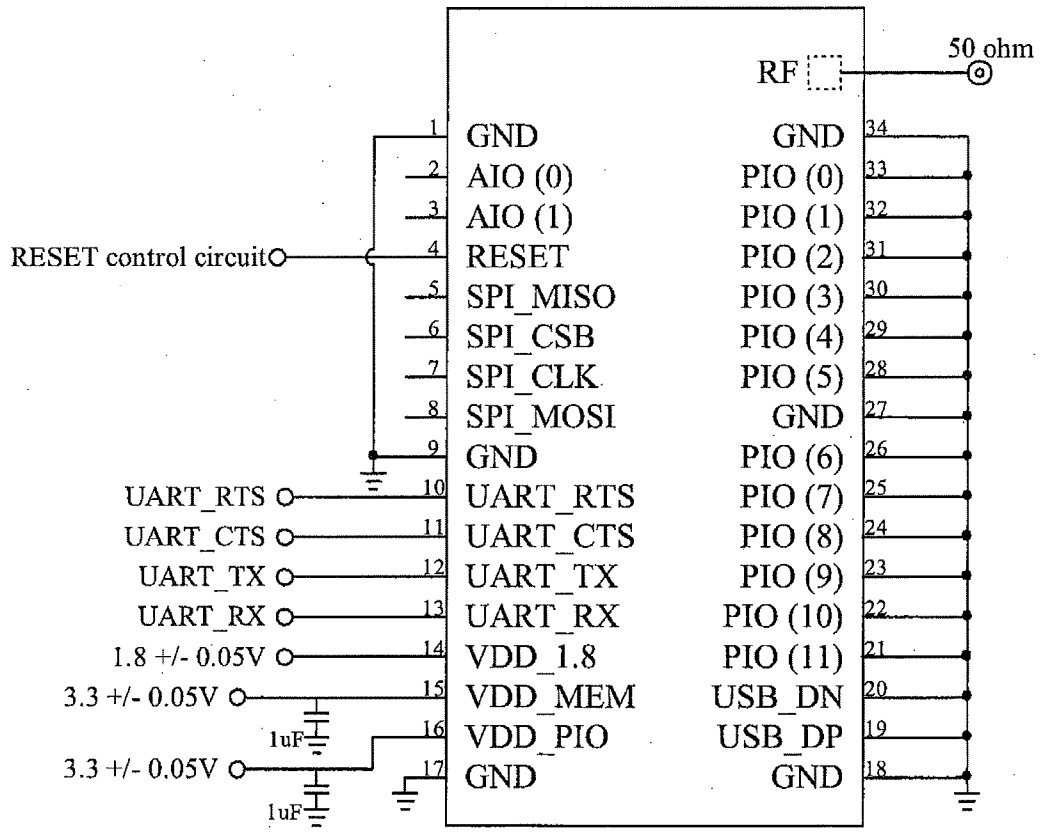
No	Parameter	Symbol	Spec			Unit	Remark
			Min	Typ	Max		
1	Frequency Range		2402		2480	MHz	0～78ch(1MHz step)
2	Initial Frequency Tolerance	IFT	-75		75	kHz	
3	Frequency Drift	FD	-25		25	kHz	DH1
4	Output Power	POW	-6	0	4	dBm	@Max Power
5	Modulation Characteristics	MC1	140	155	175	kHz	Payload: 11110000
		MC4	115	155		kHz	Payload: 10101010
6	Sensitivity	SEN		-80	-70	dBm	BER<0.1%, multi-slot

Note:

Bluetooth™ standard Ver1.1 conformity

Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD－AT－ A041010 （1／1）	Test circuit 検査回路図	Jan. 18. 2019	Jan. 18. 2019		Jan. 8. 2019

EYMF2CAMM-XV test circuit
EYMF2CAMM-XV 検査回路図



Note:
Please see "6.0 GPIO Configuration" in HD-AE-D021157-A (19/23) for detailed information about PIO.
PIO についての詳細な情報は HD-AE-D021157-A（19/23）の「6.0 GPIO Configuration」を参照下さい。

書類番号 Control No.	書類名 Control name	承認 APPROVED	確認 CHECKED	写図 DRAWN	担当 DESIGNED
HQ－BL －043 (1/1)	ロット番号解説書 Instruction for Lot Number	Jul.6.2001	Jul.6.2001		Jul.6.2001

1．ロット番号の読み方
How to read lot number.

ロット番号は、下記方法により製造年月日を表します。
Lot Number represents production year, month and date as follows.

例 ex.

8　D　G(1)

(1) 製造日、(製造区分)
Production date、(Classification)
(2) 製造月
Production month
(3) 製造年
Production year

(1) 製造日、製造区分
Production date and Classification
製造日は下表による数字、または英字記号で表す。
製造区分（同一日、複数ロット製造時の区分等）は、必要ある場合に１から連番で表示する。
Use following chart to represent production date.
Classification should be marked when multiple lots has manufactured in the same day, and the number starts from 1 in the sequence order.

日 date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
記号 code	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G

日 date	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
記号 code	H	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z

(2) 製造月
Production month
下表による数字、または英字記号で表す。
Use following chart to represent production month.

月 month	1	2	3	4	5	6	7	8	9	10	11	12
記号 code	1	2	3	4	5	6	7	8	9	O	N	D

(3) 製造年
Production year
西暦年末尾で表す。
Use last digit of dominical year to represent production year.

2．BDアドレス形式
BD address format

０００３７Ａ　□①　□②　□③　□④　□⑤　□⑥

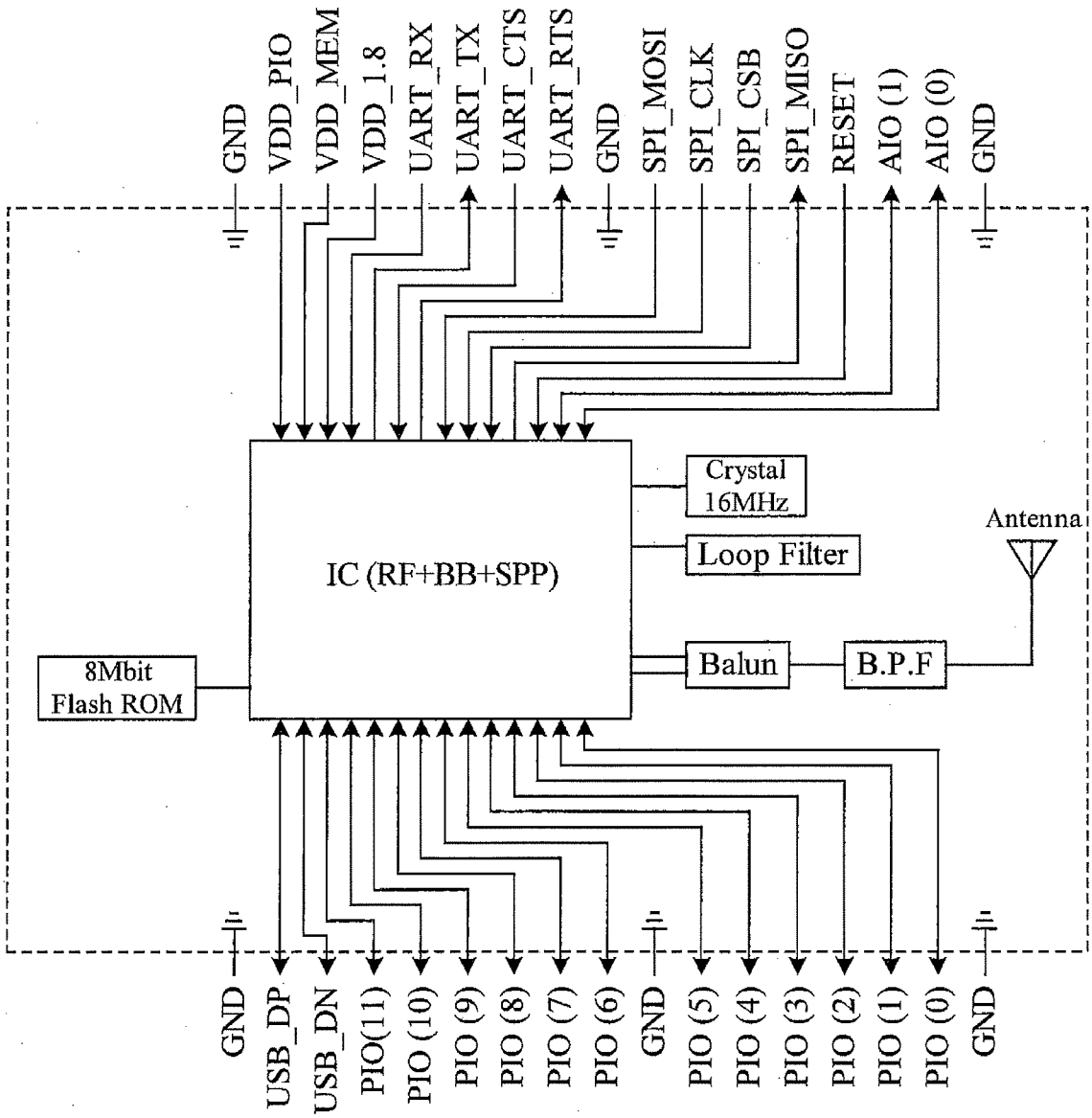
メーカーコード：００００３７Ａ→太陽誘電コード(固定)
Manufacturer code: 00037A →Fixed TAIYO YUDEN's code

(1) コードの詳細 (①～⑥)
Code description (①～⑥)
コードは全て１６進法を用いる。
１６進法にて " ００Ａ０００" から順にシリアルＮｏ．を付与する。
All the code must be in hexadecimal.
Assign the serial No. in hexadecimal notation starts from "00A000".

(2) 表示方法
Display procedure
・ＢＴモジュールのシールドケース表面にＢＤアドレスをシリアルＮｏ．として表示する。
Mark BD address as a serial number on the sealed case.
・①～⑥の１６進法シリアルＮｏ．において、割り振れることのできる全てのコードを割り振った場合は新しいメーカーコードを付与する。但し、御社に対して事前に変更通知を行うこととする。
When all the serial No. has allocated to ① thought ⑥ in hexadecimal notation, new manufacturer code should be allocated. However, manufacturer must be notified beforehand.

Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD−MC− B021157 (1/1)	Circuit schematic 内部回路図	Apr 17 '03	Apr. 17. 2003		Apr. 17. 2003

Block diagram



Control No.	Control name	APPROVED	CHECKED	DRAWN	DESIGNED
HD−BA− A021157−A (1/1)	Pin layout ピンレイアウト図	Feb.12.2004	Feb.12.2004		Feb.10.2004

Pin Descriptions

Note: Unused pins should not be connected.

No.	Pin Name	I/O	Description	Block
1	GND	-	Ground	Power
2	AIO(0)	Input/Output	Not use	GPIO
3	AIO(1)	Input/Output		GPIO
4	RESET	Input	Active high RESET. With 51k ohm internal pull-down	RESET
5	SPI_MISO	Output	The pin is used for the firmware update, PS_KEY setting and Test mode. It connects to PC.	SPI
6	SPI_CSB	Input		SPI
7	SPI_CLK	Input		SPI
8	SPI_MOSI	Input		SPI
9	GND	-	Ground	Power
10	UART_RTS	Output	Request to send.(flow control signal from host) Tri-statable with internal pull-up	UART
11	UART_CTS	Input	Clear to send.(flow control signal to host) With weak internal pull-down	UART
12	UART_TX	Output	TX data to host.	UART
13	UART_RX	Input	RX data from host. With weak internal pull-down	UART
14	VDD_1.8	Input	DC supply 1.8V	Power
15	VDD_MEM	Input	DC supply 3.3V	Power
16	VDD_PIO	Input	DC supply 3.3V	Power
17	GND	-	Ground	Power
18	GND	-	Ground	Power
19	USB_DP	Input/Output	This signal should be connected to ground	USB
20	USB_DN	Input/Output	This signal should be connected to ground	USB
21	PIO(11)	Input/Output	Not use	GPIO
△ 22	PIO(10)	Input	Configure Baud Rate[0]	GPIO
△ 23	PIO(9)	Input	Configure Baud Rate[1]	GPIO
△ 24	PIO(8)	Input	Configure Baud Rate[2]	GPIO
△ 25	PIO(7)	Input	Switch for Master/Slave mode (For Automatic Mode)	GPIO
△ 26	PIO(6)	Input	Switch for Automatic/Command control mode	GPIO
27	GND	-	Ground	Power
△ 28	PIO(5)	Output	Light LED[1]	GPIO
△ 29	PIO(4)	Input	This determines if Messages are generated in Automatic Mode	GPIO
△ 30	PIO(3)	Output	Light LED[0]	GPIO
31	PIO(2)	Input/Output	Not use	GPIO
32	PIO(1)	Input/Output	Not use	GPIO
33	PIO(0)	Input/Output	Not use	GPIO
34	GND	-	Ground	Power

Note:
Unused pins should not be connected.

Control No.	Control name	APPROVED	CHECKED	DRAWN	PREPARED
HQ−BA−506	Handling Precaution	Apr.3.2003 M.Akiyoshi	Apr.3.2003 Y.Tsuruta		Apr.3.2003 F.Ito.
(1/3)	取扱注意要領				

This specification describes desire and conditions especially for mounting.
本書類では特に実装時の　御願い・条件　について記載します。

Desire／Conditions
御願い・条件

(1) Environment conditions for use and storage
使用・保管環境の管理

1. Store the components in an environment of < **40℃/90%RH** if they are in a moisture barrier bag packed by TAIYO YUDEN.
弊社出荷時の防湿梱包状態で保管する場合、**40℃/90%RH** 以下の環境で保管してください。

2. Keep the factory ambient conditions at < **30℃/60%RH** .
工程の環境は **30℃/60%RH** 以下に管理してください。

3. Store the components in an environment of < **25±5℃/10%RH** after the bag is opened.
(The condition is also applied to a stay in the manufacture process).
モジュールを開梱状態で保管する(工程間の滞留含む)場合、**25±5℃/10%RH** 以下の環境で保管してください。

(2) Conditions for handling of products
製品取扱時の御願い・条件

Make sure all of the moisture barrier bags have no holes, cracks or damages at receiving. If an abnormality is found on the bag, its moisture level must be checked in accordance with 2 in (2).
防湿梱包品入庫後、防湿袋に穴、裂け、キズ等のない事を確認してください。万が一異常があった場合、(2)-2項に従い、処置をお願い致します。

Refer to the label on the bag.
梱包に貼付のラベルをご参照ください。

1.All of the surface mounting process (reflow process) must be completed in **12 months** from the bag sea date.
梱包日から12ヶ月以内に全ての実装(リフロー)作業(リワーク含む)を終了してください。

2. Make sure humidity in the bag is less than **10%RH** immediately after open, using a humidity indicator card sealed with the components.
When the humidity indicator card shows **blue** at 10%, it means the humidity is less than 10%RH.
In case of **pink** or **lavender** instead of blue, bake the components in accordance with 4 in (2).
防湿梱包開梱後、直ちに湿度ｲﾝｼﾞｹｰﾀｰにて梱包内の環境が＜**10%RH** であることを確認してください。
10%表示の部分が青色であれば、10%RH 以下であったと判断できます。
ピンク及びラベンダーの場合(2)-5 項に従いベーキングを行ってください。

3. **All** of the surface mounting process (reflow process including rework process) must be completed in **72 hours** after the bag is opened (inclusive of any other processes).
開封後**72時間以内**に全ての実装作業(リワーク含むリフロー作業)を終了してください。
本モジュール以外の実装作業含みます

4. If any conditions in (1) or condition 2 and 3 in (2) are not met, bake the components in accordance with the conditions at **125℃ 24h**
(1)項、及び(2)-3・(2)-4の基準からはずれた場合、**125℃ 24h**にてベーキングを行って下さい。

5. As a rule, baking the components in accordance with conditions 4 in (2) shall be once.
(2)-4 項記載の条件によるベーキングは 1 回を原則とします。

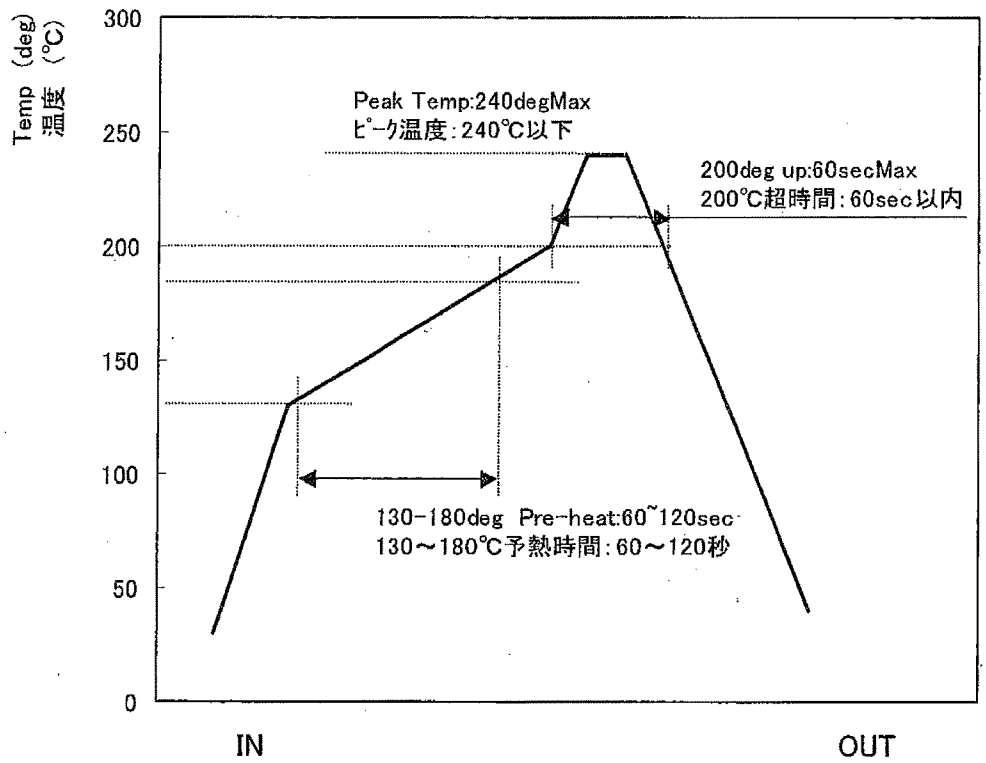
6. Antistatic bands must be removed from the components prior to baking.
ベーキングは、帯電防止バンドをはずした状態で行ってください。

7. Since semi-conductors are inside of the components, they must be free from static electricity while handled.(<250V) Use ESD protective floor mats, wrist straps, ESD protective footwears, air ionizers etc. , if necessary.
本モジュールは内部に半導体を有するため、取扱中には静電気に留意してください。(250V以下) 必要に応じて、導電マット・アースバンド・静電靴・イオナイザー等を用いて、静電気の対策を講じてください。

8. Please make sure that there are lessen mechanical vibration and shock for this module, and do not drop it.
機械的振動、衝撃を極力少なくし、落下させないでください。

9. Please perform temperature conditions of module at reflow within the limits of the following.
モジュールのリフロー時温度条件は、下記の範囲内で行って下さい。

Please give the number of times of reflow as a maximum of 2 times.
リフロー回数は最大２回として下さい。



Please use an external terminal of module at reflow temperature measurement.

温度測定は、ﾓｼﾞｭｰﾙの外部端子を使用して下さい。

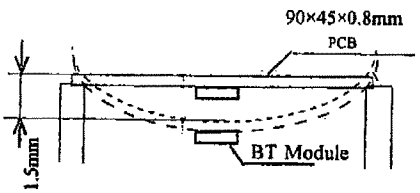
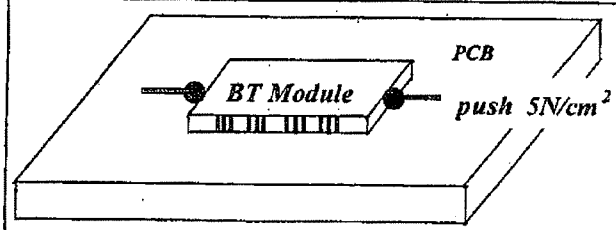
10. Please perform conditions of module at soldering irons within the limits of the following.
Surface temp of irons : 420deg Max (4sec Max／1Pad)

半田コテを使用する場合は、420℃Max 4secMax（1端子当り） の範囲内で行って下さい。

Control No	Control name	APPROVAL	CHECKED	DRAWN	DESIGNED
RT5991-004A (1/ 2)	The Terms of Reliability Tests 信頼性条件書	3 Apr '03 T.Matsushima	2 Apr. '03 H.Ichikawa		2, Apr. '03 M.Sakurai

Tests 試験項目	Testing Methods 試験条件	Judgment criteria 判定基準
High Temperature Test (Non Biased) 高温保存	Devices are left for 2~24 hours in the normal temperature and humidity after being placed in a high temperature(110deg-C) environment for 250 hours, while no voltage is applied. １１０℃の雰囲気中に２５０時間放置後、取り出して常温常湿中に２～２４時間放置後測定。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。
Low Temperature Test (Non Biased) 低温保存	Devices are left for 2~24 hours in the normal temperature and humidity after being placed in a Low temperature(-40deg-C) environment for 250 hours, while no voltage is applied. －４０℃の雰囲気中に２５０時間放置後、取り出して常温常湿中に２～２４時間放置後測定。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。
Humidity Test (Non Biased) 高温高湿保存	Devices are left for 2~24 hours in the normal temperature and humidity after being exposed to 85% humidity at 85deg-C for 250 hours, while no voltage is applied. ８５℃、８５%ＲＨの雰囲気中に２５０時間放置後、取り出して常温常湿中に２～２４時間放置後測定。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。
Humidity Test (Biased) 高温高湿連続バイアス	Devices are left for 2~24 hours in the normal temperature and humidity after being exposed to 95% humidity at 60deg-C for 250 hours,operating the receiver and transmitter electric circuit of devices. ６０℃、９５%ＲＨの雰囲気中で２５０時間送受信共連続動作後、取り出して常温常湿中に２～２４時間放置後測定。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。
High Temperature Test (Biased) 高温連続動作	Devices are left for 2~24 hours in the normal temperature and humidity after being placed in a high temperature (75deg-C) environment for 100 hours, operating the receiver and transmitter electric circuit of devices. ７５℃の雰囲気中で１００時間送受信共連続動作後、取り出して常温常湿中に２～２４時間放置後測定。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。
Thermal Shock Test (Air) 温度サイクル	Devices are left for 2~24 hours in the normal temperature and humidity after being placed at two different temperature (-30~85 deg-C) in the atmosphere for 30 minutes respectively and this cycle is repeated 100 times. 気中で、－３０℃(３０)⇔常温１０秒以内⇔８５℃(３０分)に順次入れこれを１００サイクル繰り返した後、常温常湿中に２～２４時間放置後測定。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。

Control No	Control name	APPROVAL	CHECKED	DRAWN	DESIGNED
RT5991-004A (2/ 2)	The Terms of Reliability Tests 信頼性条件書	3 Apr '03 T.Matsushima	2 Apr. '03 H.Ichihara		2. Apr. '03 M.Sakurai

Tests 試験項目	Testing Methods 試 験 条 件	Judgment criteria 判定基準
ESD 静電破壊	C=200pF,R=0Ω, ±100V,each 5 times ２００ｐＦ,０Ω ±１００Ｖ 各５回実施後測定。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。
Vibration Test 振動	Devices are fixed to a vibration table. overalll amplitude of vibration:1.5mm at f=10~82Hz acceleration of vibration:196m/s²20G at f=82~2000Hz sweep time:4 minuites (f=10~2000~10Hz) X,Y,and Z axis for 2 hours each for a total of 6 hours. １０～８２Ｈｚ：全振幅１．５㎜、８２～２０００Ｈｚ：加速度１９６m/S²{２０Ｇ}、周期４分でＸ、Ｙ、Ｚ各方向２時間、計６時間振動させた後測定。	Devices should show no abnormal electrical performance and no unusual external appearance. 電気的特性・外観に異常ないこと。
Solder Heat Resistance Test リフロー はんだ耐熱性	Peak temperature 240deg-C, 2 times ピーク温度２４０℃、リフロー回数２回。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。
Bending Test たわみ試験	Bending : 1time ,Holding: 2sec  ９０mm×４５mm×０．８mmのプリント板のセンターに部品をはんだ付け後３点曲げ試験を行う。プリント基板を中央から１．５mm,２秒間１回押す。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。
Lead Strength Test 端子強度	 試験基板にはんだ付け後、端子電極のない側面より５Ｎ／cm². の加重を加える。	Devices should show no abnormal electrical performance. 電気的特性に異常ないこと。

Control No.	Title	Approved	Checked	Drawn	Prepared
HD-BB- A041010 (1/2)	Packaging Specification 梱包仕様書	Jun.18.2004 Y.Tsumita			Jun.18.2004 Y.Tsumita

Packaging Specification
梱包仕様

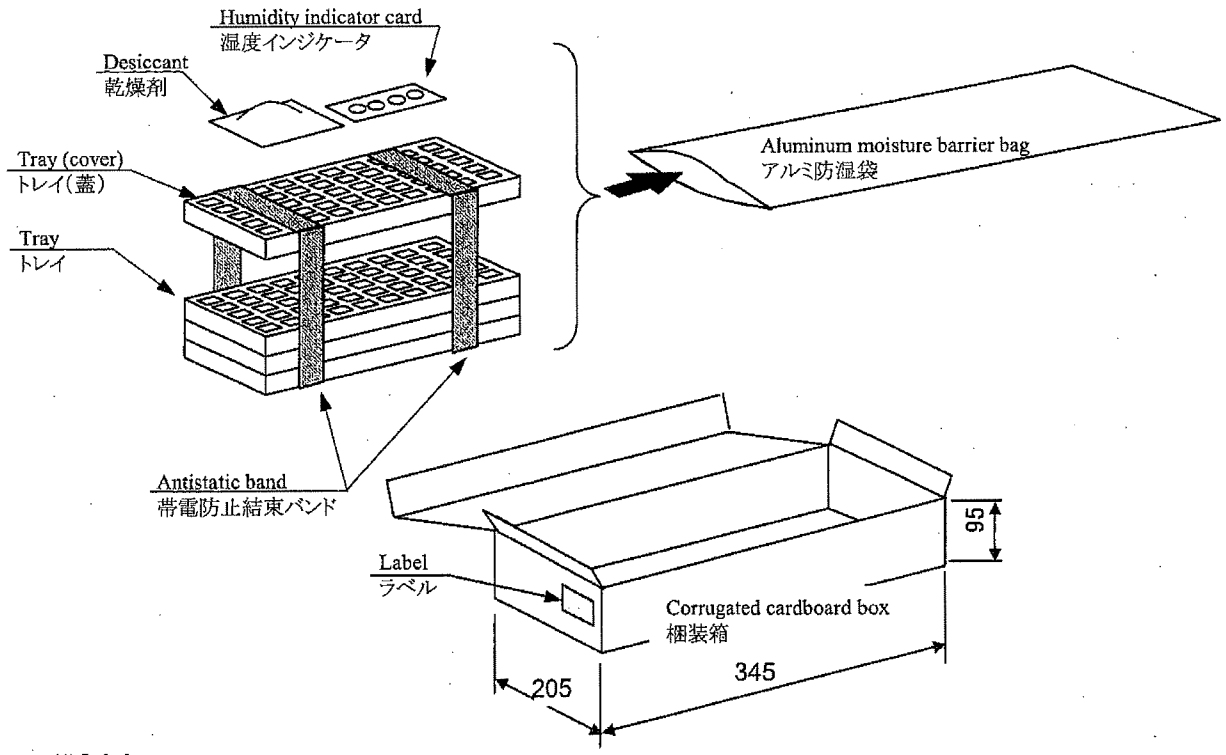
(1) Packaging Material
梱包材料

Name 部材名	Outline 概要	Materials 材質	Note 備考
Tray トレイ	315×135.9×7.62(mm)	Conductive PPE 導電性PPE	40 pieces/tray 40 個/トレイ
Antistatic band 帯電防止結束バンド	8mm wide 8mm幅	Antistatic PP 帯電防止 PP	
Desiccant 乾燥剤	30g×1	Desi-Pak デシパック	
Humidity indicator card 湿度インジケータ	10-20-30-40%		
Aluminum moisture barrier bag アルミ防湿袋	260×460(mm)	(AS)PET/AL/NY/PE(AS)	
Label ラベル			
Corrugated cardboard box 梱装箱	345×205×95(mm)		

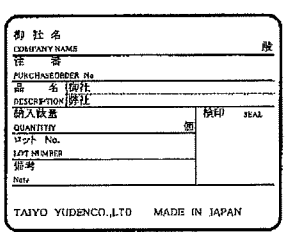
(2) Packaging Unit
梱包数量

40 pieces/tray × 10 tray = 400 pieces
40 個/トレイ × 10 トレイ = 400 個

(3) Packaging Figure

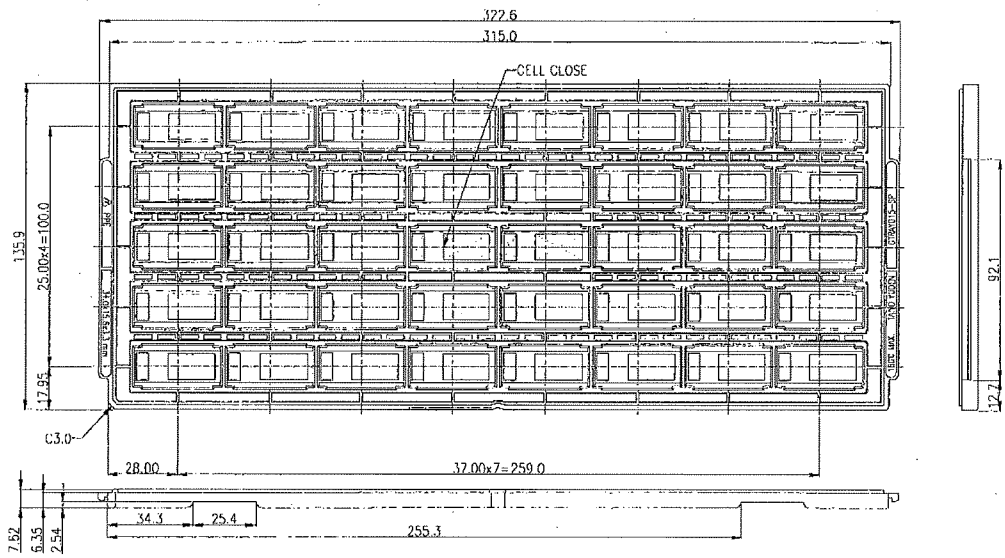


(4) Label
ラベル

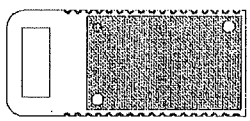


Control No.	Title	Approved	Checked	Drawn	Prepared
HD-BB- A041010 (2/2)	Packaging Specification 梱包仕様書	Jun.18.2004 Y.Tsumura			Jun.18.2004 Y.Tsumura

Tray Figure
トレイ図面



Direction
収納方向



First Pin Mark
1ピンマーク

Note
備考

- *150 ℃ MAX*
- *SURFACE ELECTRICAL RESISTIVITY : 10^5 ～10^{11} Ω/□ (BY TEST ASTM D257)*
- *WARPAGE:LESS THAN 0.80mm*

- 耐熱温度150℃
- 表面抵抗：10^5～10^{11}Ω/□ (ASTM D257 試験による)
- 反りは、0.80mm未満

Supported Serial Port Profile.

The ***Bluetooth***™ functions of this module is as written in the attached PICS. Depending on firmware version Upgrade, the ***Bluetooth***™ functions are subject to change without notice.

Serial Port Profile Capabilities (based on PICS proforma for Serial port Profile)

Table K:5.1: Device role

Item	Capability	Status	Support
1	Device A (DevA)	O.1	Yes
2	Device B (DevB)	O.1	Yes

O.1: It is mandatory to support at least one of the defined roles.

Table K:5.2: Application procedures (DevA)

Item	Capability	Status	Support
1	Establish link and set up virtual serial connection	M	Yes
2	Accept link and virtual serial connection establishment	X	No
3	Register Service record for application in local SDP database	X	no
4	No release in Sniff mode. Sniff mode enabled in the Link Manager	O	Yes
5	No release in Hold mode. Hold mode enabled in the Link Manager	O	No
6	No release in Park mode. Park mode enabled in the Link Manager	O	Yes
7	No release after Master/Slave switch. M/S switch enabled in the link manager	O	No

X – Not used in DevA role

Table K:5.8: Application procedures (DevB)

Item	Capability	Status	Support
1	Establish link and set up virtual serial connection	X	No
2	Accept link and virtual serial connection establishment	M	Yes
3	Register Service record for application in local SDP database	M	Yes
4	No release in Sniff mode. Sniff mode enabled in the Link Manager	O	Yes
5	No release in Hold mode. Hold mode enabled in the Link Manager	O	No
6	No release in Park mode. Park mode enabled in the Link Manager	O	Yes
7	No release after Master/Slave switch. M/S switch enabled in the link manager	O	No

X – Not used in DevB role

Module Stack