
Integrated Transceiver Modules (900 MHz) Development Kit Available

FEATURES

- 250mW output power
- Long range
- Up to 500 kBaud RF data rate
- 128 bit AES encryption available
- Miniature footprint: 0.9" x 1.63"
- Multiple antenna options
- Certifiable for FCC and IC acceptance
- MSP430 based CPU
- Low power operation
- RoHS compliant
- Streamlined development with LSR design services.
- License options available to purchase design or integrate design.

APPLICATIONS



- Security
- Lighting Control
- HVAC Control
- Sensor Networks
- Medical
- Industrial Automation

DESCRIPTION

The SiFLEX01 module is a high performance 900MHz radio based on the Texas Instruments CC430 combined with the CC1190 front-end in a cost effective footprint.

Need to get to market quickly? Not an expert in frequency hopping? Need a custom antenna? Would you like to own the design? Would you like a custom design? Not quite sure what you need? Do you need help with your host board? LS Research Design Services will be happy to develop custom hardware or software, integrate the design, or license the design so you can manufacture yourself. Contact us at sales@lsr.com or call us at 262-375-4400.

MODULE ACCESSORIES

	Order Number	Description
	001-0002	900 MHz Dipole Antenna with Reverse Polarity SMA Connector
	080-0001	U.FL to Reverse Polarity SMA Bulkhead Cable 105mm

BLOCK DIAGRAM

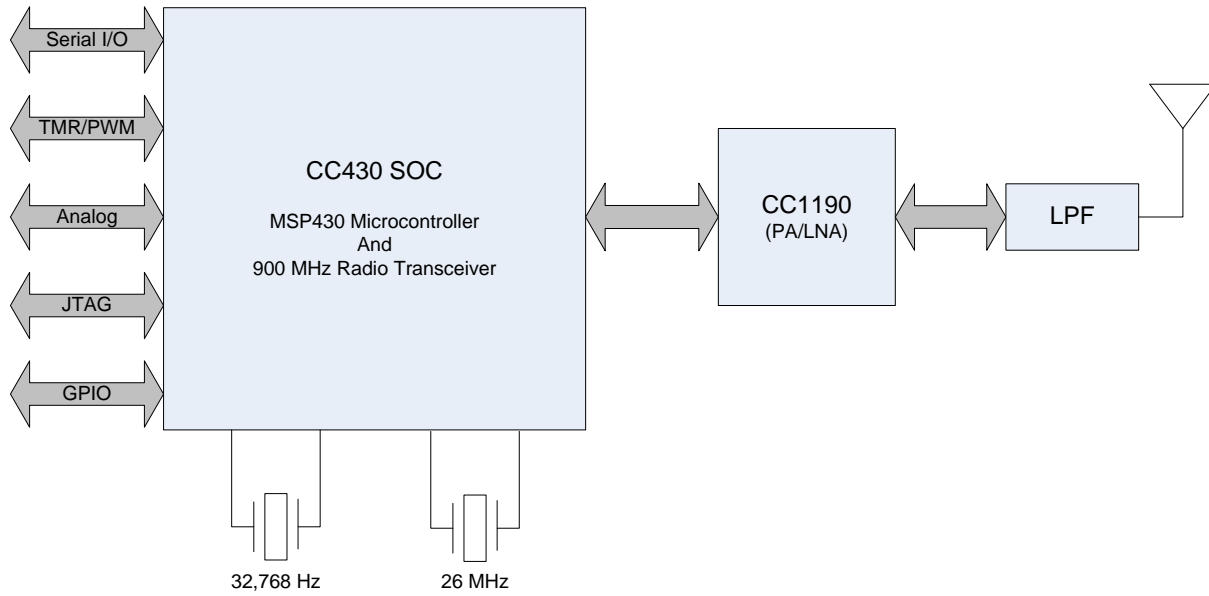


Figure 1 SiFLEX01 Module Block Diagram – High-Level

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MODULE PINOUT AND PIN DESCRIPTIONS

MCU#	GND	1																	69	GND	MCU#
-	GND	2																	68	GND	-
-	GND	3																	67	GND	-
-	NC	4																	66	NC	-
-	NC	5																	65	NC	-
-	NC	6																	64	NC	-
-	NC	7																	63	NC	-
-	NC	8																	62	NC	-
48	JTAG TMS	9																	61	P1.3	13
47	JTAG TDI	10																	60	P1.2	14
49	JTAG TCK	11																	59	P1.4	12
46	JTAG TDO	12																	58	P5.4	9
50	TEST	13	Texas Instruments CC430F6137																57	P1.3	13
51	nRESET	14																	56	P1.2	14
59	P2.5	15																	55	PJ.3	49
60	P2.4	16																	54	PJ.2	48
58	P2.6	17																	53	PJ.1	47
57	P2.7	18																	52	PJ.0	46
24	P3.0	19																	51	P5.3	34
64	P2.0	20																	50	P5.7	6
63	P2.1	21																	49	P5.6	7
62	P2.2	22																	48	P4.7	26
61	P2.3	23																	47	P4.6	27
60	P2.4	24																	46	P4.5	28
59	P2.5	25																	45	P4.4	29
-	VCC - 3V3DC	26																	44	GND	-
			27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43		
			P3.1	P3.2	P3.3	P3.4	P3.5	P3.6	P3.7	P3.0	P1.6	P1.5	P5.2	P5.3	P1.7	P4.0	P4.1	P4.2	P4.3		
MCU#			23	22	21	20	19	18	17	24	2	3	35	34	1	33	32	31	30	MCU#	

Figure 2 Module Pinout

Module Pin	Name	MCU Pin	Type	Description
1	GND	N/A	GND	Ground
2	GND	N/A	GND	Ground
3	GND	N/A	GND	Ground
4	NC	N/A	NC	No Connect
5	NC	N/A	NC	No Connect
6	NC	N/A	NC	No Connect
7	NC	N/A	NC	No Connect
8	NC	N/A	NC	No Connect
9	JTAG TMS	48	I/O	General-purpose digital I/O (PJ.2), JTAG TMS
10	JTAG TDI	47	I/O	General-purpose digital I/O (PJ.1), JTAG TDI
11	JTAG TCK	49	I/O	General-purpose digital I/O (PJ.3), JTAG TCK
12	JTAG TDO	46	I/O	General-purpose digital I/O (PJ.0), JTAG TDO
13	TEST/SBWTCK	50	I/O	TEST / SBWTCK
14	nRESET	51	Input	/RESET / NMI / SBWTDIO
15	VREF+	59	I/O	General-purpose digital I/O (P2.5), ADC5, Analog VREF+
16	VREF-	60	I/O	General-purpose digital I/O (P2.4), ADC4, Analog VREF-
17	CMP+	58	I/O	General-purpose digital I/O (P2.6), CB6, ADC6
18	CMP-	57	I/O	General-purpose digital I/O (P2.7), CB7, ADC7
19	CMPOUT	24	I/O	General-purpose digital I/O (P3.0), CBOUT
20	ADC1	64	I/O	General-purpose digital I/O (P2.0), CB0, ADC0
21	ADC2	63	I/O	General-purpose digital I/O (P2.1), CB1, ADC1
22	ADC3	62	I/O	General-purpose digital I/O (P2.2), CB2, ADC2
23	ADC4	61	I/O	General-purpose digital I/O (P2.3), CB3, ADC3
24	ADC5	60	I/O	General-purpose digital I/O (P2.4), CB4, ADC4
25	ADC6	59	I/O	General-purpose digital I/O (P2.5), CB5, ADC5
26	VCC - 3V3DC		VCC	Supply Voltage
27	TMR/PWM1	23	I/O	General-purpose digital I/O (P3.1), TA0CCR0A
28	TMR/PWM2	22	I/O	General-purpose digital I/O (P3.2), TA0CCR1A
29	TMR/PWM3	21	I/O	General-purpose digital I/O (P3.3), TA0CCR2A
30	TMR/PWM4	20	I/O	General-purpose digital I/O (P3.4), TA0CCR3A
31	TMR/PWM5	19	I/O	General-purpose digital I/O (P3.5), TA0CCR4A
32	TMR/PWM6	18	I/O	General-purpose digital I/O (P3.6)
33	TMR/PWM7	17	I/O	General-purpose digital I/O (P3.7)

The information in this document is subject to change without notice.

Module Pin	Name	MCU Pin	Type	Description
34	TMR/PWM8	24	I/O	General-purpose digital I/O (P3.0), TA0CLK
35	UART TX	2	I/O	General-purpose digital I/O (P1.6), UCA0TXD
36	UART RX	3	I/O	General-purpose digital I/O (P1.5), UCA0RXD
37	UART CTS	35	I/O	General-purpose digital I/O (P5.2)
38	UART RTS	34	I/O	General-purpose digital I/O (P5.3)
39	GPIO1	1	I/O	General-purpose digital I/O (P1.7)
40	GPIO2	33	I/O	General-purpose digital I/O (P4.0)
41	GPIO3	32	I/O	General-purpose digital I/O (P4.1)
42	GPIO4	31	I/O	General-purpose digital I/O (P4.2)
43	GPIO5	30	I/O	General-purpose digital I/O (P4.3)
44	GND		GND	Ground
45	GPIO6	29	I/O	General-purpose digital I/O (P4.4)
46	GPIO7	28	I/O	General-purpose digital I/O (P4.5)
47	GPIO8	27	I/O	General-purpose digital I/O (P4.6)
48	GPIO9	26	I/O	General-purpose digital I/O (P4.7)
49	GPIO10	7	I/O	General-purpose digital I/O (P5.6)
50	GPIO11	6	I/O	General-purpose digital I/O (P5.7)
51	GPIO12	34	I/O	General-purpose digital I/O (P5.3)
52	GPIO13	46	I/O	General-purpose digital I/O (PJ.0/TDO)
53	GPIO14	47	I/O	General-purpose digital I/O (PJ.1/TDI)
54	GPIO15	48	I/O	General-purpose digital I/O (PJ.2/TMS)
55	GPIO16	49	I/O	General-purpose digital I/O (PJ.3/TCK)
56	I ² C-SCL	14	I/O	General-purpose digital I/O (P1.2), UCB0SCL
57	I ² C-SDA	13	I/O	General-purpose digital I/O (P1.3), UCB0SDA
58	SPI-SS	9	I/O	General-purpose digital I/O (P5.4)
59	SPI-SCK	12	I/O	General-purpose digital I/O (P1.4), UCB0CLK
60	SPI-MISO	14	I/O	General-purpose digital I/O (P1.2), UCB0SOMI
61	SPI-MOSI	13	I/O	General-purpose digital I/O (P1.3), UCB0SIMO
62	NC	N/A	NC	No Connect
63	NC	N/A	NC	No Connect
64	NC	N/A	NC	No Connect
65	NC	N/A	NC	No Connect
66	NC	N/A	NC	No Connect

The information in this document is subject to change without notice.

Module Pin	Name	MCU Pin	Type	Description
67	GND	N/A	GND	Ground
68	GND	N/A	GND	Ground
69	GND	N/A	GND	Ground

Table 1 SiFLEX01 Module Pin Descriptions

MODULE OVERVIEW

Figure 3 shows the internal interconnects of the ICs on the SiFLEX01 module. Consult the respective IC datasheets for details, or contact LSR sales to purchase the SiFLEX01 module schematics as part of LSR’s ModFLEX™ design program. For a high-level block diagram of the SiFLEX01 module, see Figure 1.

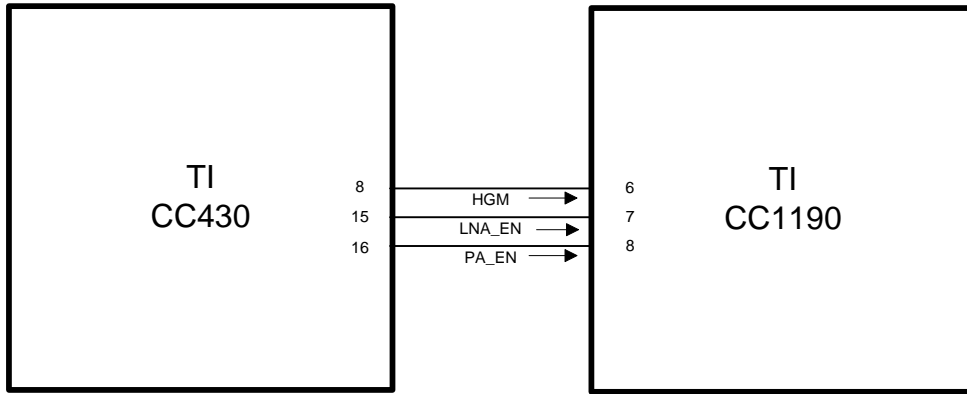


Figure 3 SiFLEX01 Module Block Diagram – Internal Interconnects

Microcontroller

The CC430 contains an MSP430 16 bit RISC core with 16 registers. The radio registers allow access to radio functions without the bottleneck of an intermediate interface.

There are 5 modes of operation including Active Mode and 4 low power modes with progressively lower power achieved through disabling peripherals and clocks.

RAM is organized into 2k sectors which can be powered down to save current when not in use. Data is not retained during power-down.

A DMA controller is included to allow direct memory to memory transfers without CPU intervention. DMA can remain active in some sleep modes for increased power savings.

A hardware AES encryption engine is included to allow 128 bit Advanced Encryption Standard (AES) (FIPS PUB 197) to be implemented without excessive firmware burden.

Figure 4 shows a block diagram of the CC430.

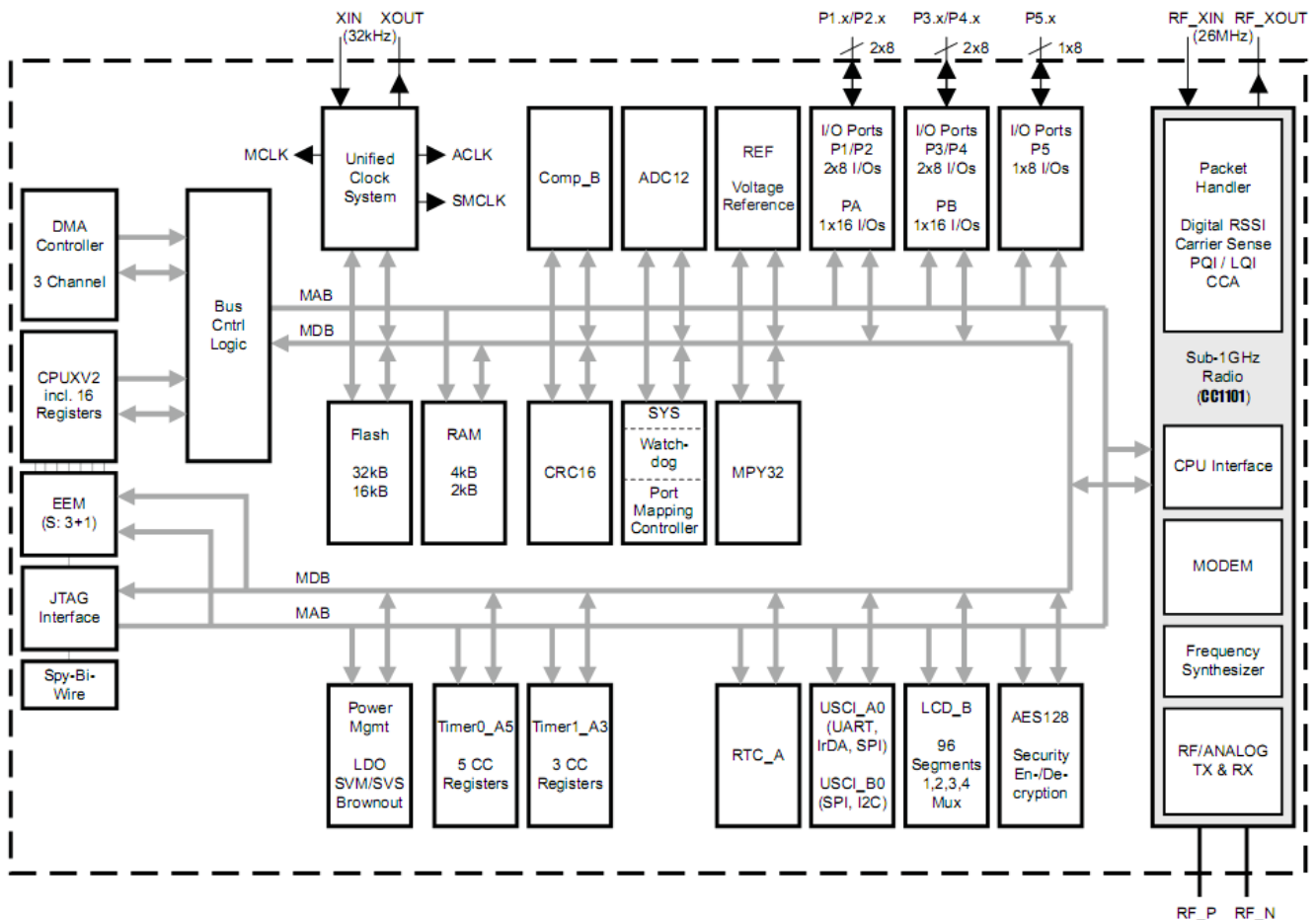


Figure 4 CC430F613x Block Diagram

Radio

The internal radio is based on the TI CC1101. It is a low-IF type with all digital AGC and filtering.

Memory mapped registers are used for data access and controlling radio characteristics.

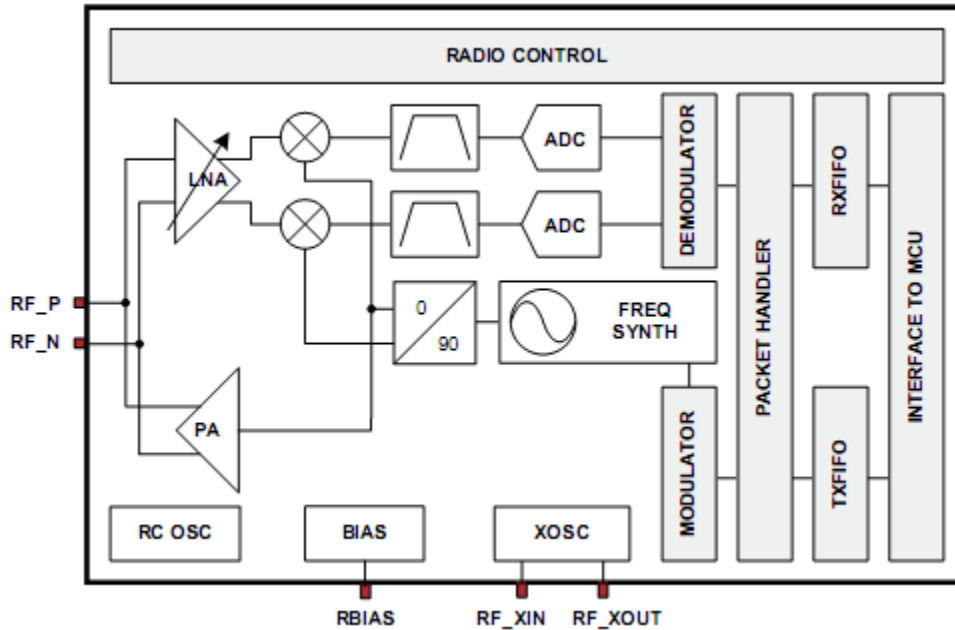


Figure 5 CC430 Sub 1 GHz Radio Block Diagram

RF Power Amplifier

The SiFLEX01 module contains a TI CC1190 front-end chip. It is capable of 250mW output power.

When transmitting the PA_EN signal will be high and LNA_EN will be low, which is controlled by the firmware using GPIO pins P1.0 and P1.1. When receiving PA_EN is low and LNA_EN is high. LNA gang is be adjusted to a high or low setting with the HGM signal controlled by P5.5.

PA_EN P1.0	LNA_EN P1.1	HGM P5.5	Operation
0	0	X	Shutdown
0	1	0	RX low gain
0	1	1	RX high gain
1	0	0	TX low gain
1	0	1	TX high gain

Table 2 Front-end control functions

Antenna Options

The SiFLEX01 module includes multiple antenna options. The module regulatory certification can be completed with the following options:

Certified Antenna Options

- LSR 001-0002 900 MHz Dipole Antenna with Reverse Polarity SMA Connector and LSR 080-0001 U.FL to Reverse Polarity SMA Bulkhead Cable 105mm.
- Antenna Factor ANT-916-CW-HWR-RPS 900 MHz Dipole Antenna with Reverse Polarity SMA Connector and PanguTech JQ-0036-L4 MMCX to Reverse Polarity SMA Cable.

Non-certified Antenna Options

- Integrated 3.2-inch wire monopole soldered to the board.
- Off-board antenna using the castellated edge connection to a 50Ω trace on the host board

An adequate ground plane is necessary to provide good efficiency. The ground plane of the host board on which the module is mounted increases the effective antenna ground plane size and improves the antenna performance.

The environment the module is placed in will dictate the range performance. The non-ideal characteristics of the environment will result in the transmitted signal being reflected, diffracted, and scattered. All of these factors randomly combine to create extremely complex scenarios that will affect the link range in various ways.

It is also best to keep some clearance between the antenna and nearby objects. This includes how the module is mounted in the product enclosure. Unless the items on the following list of recommendations are met, the radiation pattern can be heavily distorted.

Whichever antenna is used, it is best to keep a few things in mind when determining its location.

- Never place ground plane or copper trace routing underneath the antenna.
- LSR recommends keeping metal objects as far away from the antenna as possible. At a very minimum keep the antenna at least 5 cm from any metallic objects, components, or wiring. The farther the antenna is placed from these interferers, the less the radiation pattern and gain will be perturbed.
- Do not embed the antenna in a metallic or metalized plastic enclosure.
- If located within a plastic enclosure, keep the enclosure at least 1 cm from the antenna.

DEVELOPMENT TOOLS

TI MSP-FET430UIF

Custom firmware development can be done on the SiFLEX module using development tools available through TI. Shown in Figure 6, a MSP-FETUIF USB interface is required. It plugs directly into the SiFLEX Development Board, and can easily be adapted to other hardware. See the Texas Instruments website for more information.



Figure 6 MSP-FET430UIF

IAR Embedded Workbench for MSP430

Also required is Embedded Workbench for TI MSP430 from IAR Systems. IAR Embedded Workbench for MSP430 is an integrated development environment for building and debugging embedded applications. Visit the IAR Systems website for additional information.

ELECTRICAL SPECIFICATIONS

The majority of these characteristics are based on the use of developmental test firmware written by LSR. Custom firmware may require these values to be re-characterized by the customer.

Absolute Maximum Ratings

Rating	Min	Max	Unit
Power supply voltage	0	3.6	V
Voltage on any pin with respect to ground	-0.3	V _{CC} + 0.3	V
RF input power		+10	dBm
Operating temperature range	-40	+85	°C
Storage temperature	-50	+150	°C

Table 3 Absolute Maximum Ratings¹

Recommended Operating Conditions

Characteristic	Min	Typ	Max	Unit
Power supply voltage (V _{DD})	2.2	3.3	3.45	V _{DC}
Ambient temperature range	-40	25	85	°C

Table 4 Recommended Operating Conditions

Module will NOT transmit, if VCC > 3.5V.

General Characteristics

Parameter	Min	Typ	Max	Unit
RF frequency range	906		924	MHz
RF data rate	0.8		500	kbps
Flash program memory		32		kB
RAM		4		kB
Flash data memory		512		B

Table 5 General Characteristics

¹ Under no circumstances should exceeding the maximum ratings specified in the Absolute Maximum Ratings section be allowed. Stressing the module beyond these limits may result permanent damage to the module that is not covered by the warranty.

Power Consumption

($T_a = 25^\circ\text{C}$, $V_{CC} = 3.3\text{V}$, $f_c = 906\text{-}924\text{MHz}$, $R_{load} = 50\Omega$)

Parameter	Test Conditions	Min	Typ	Max	Unit
Transmit mode			275		mA
Receive mode			24		mA
Sleep mode			3		μA

Table 6 Power Consumption

DC Characteristics – General Purpose I/O

Parameter	Test Conditions	Min	Typ	Max	Unit
V_{it+} Positive-going input threshold voltage	$V_{CC} = 3.0\text{V}$	1.50		2.10	V
V_{it-} Negative-going input threshold voltage	$V_{CC} = 3.0\text{V}$	0.75		1.65	V
V_{hys} Input voltage hysteresis ($V_{it+} - V_{it-}$)	$V_{CC} = 3.0\text{V}$	0.4		1.0	V
V_{OL} Low-Level output voltage, full drive strength	$I_{out} = 15\text{mA}$ $V_{CC} = 3.0\text{V}$	V_{SS}		$V_{SS} + 0.60$	V
V_{OH} High-Level output voltage, full drive strength	$I_{out} = -15\text{mA}$ $V_{CC} = 3.0\text{V}$	$V_{CC} - 0.60$		V_{CC}	V

Table 7 DC Characteristics – General Purpose I/O

AGENCY CERTIFICATIONS

FCC ID: TFB-SISEN1, 15.247

IC ID: 5969A-SISEN1, RSS 210

AGENCY STATEMENTS

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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

FCC CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Industry Canada Statements

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

This device has been designed to operate with the antennas listed below, and having a maximum gain of 2 dBi (LS Research dipole) and 2 dBi (Antenna Factor dipole). Antennas not included in this list or having a gain greater than 2 dBi and 2 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

List of all Antennas Acceptable for use with the Transmitter

- 1) LS Research 001-0002 900 MHz Dipole Antenna with Reverse Polarity SMA Connector and LS Research 080-0001 U.FL to Reverse Polarity SMA Cable.
- 2) Antenna Factor ANT-916-CW-HWR-RPS 900 MHz Dipole Antenna with Reverse Polarity SMA Connector and PanguTech JQ-0036-L4 MMCX to Reverse Polarity SMA Cable.

Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement du dispositif.

Pour réduire le risque d'interférence aux autres utilisateurs, le type d'antenne et son gain doivent être choisies de façon que la puissance isotrope rayonnée équivalente (e.i.r.p) ne dépasse pas celle admise pour une communication réussie.

Cet appareil a été conçu pour fonctionner avec les antennes énumérées ci-dessous, et d'avoir un gain maximum de 2 dBi (LS Research dipôle) et 2 dBi (Antenna Factor dipôle). Antennes pas inclus dans cette liste ou d'avoir un gain plus grand que 2 et 2 dBi dBi sont strictement interdites pour l'utilisation avec cet appareil. L'impédance d'antenne requise est de 50 ohms.

Liste de toutes les antennes acceptables pour une utilisation avec l'émetteur

- 1) LS Research 900 001-0002 antenne dipôle MHz avec connecteur SMA inversé la polarité et de la LS Research LS 080-0001 U. FL à Reverse SMA à polarité du câble.
- 2) Antenna Factor ANT-916-CW-HWR-RPS 900 MHz Antenne dipôle avec connecteur SMA inversé la polarité et la PanguTech JQ-0036-L4 MMCX pour câble SMA inversé la polarité.

OEM Responsibilities to comply with FCC and Industry Canada Regulations

The SiFLEX01 Module has been certified for integration into products only by OEM integrators under the following conditions:

This device is granted for use in Mobile only configurations in which the antennas used for this transmitter must be installed to provide a separation distance of at least 20cm from all person and not be co-located with any other transmitters except in accordance with FCC and Industry Canada multi-transmitter product procedures.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

IMPORTANT NOTE: In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID and IC Certification Number cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC and Industry Canada authorization.

Le module SiFLEX01 a été certifiée pour l'intégration dans les produits que par les intégrateurs OEM dans les conditions suivantes:

Ce dispositif est accordé pour une utilisation dans des configurations mobiles seule dans laquelle les antennes utilisées pour cet émetteur doit être installé pour fournir une distance de séparation d'au moins 20cm de toute personne et ne pas être co-localisés avec les autres émetteurs, sauf en conformité avec FCC et Industrie Canada, multi-émetteur procédures produit.

Tant que les deux conditions précitées sont réunies, les tests de transmetteurs supplémentaires ne seront pas tenus. Toutefois, l'intégrateur OEM est toujours responsable de tester leur produit final pour toutes les exigences de conformité supplémentaires requis avec ce module installé (par exemple, les émissions appareil numérique, les exigences de périphériques PC, etc.)

NOTE IMPORTANTE: Dans le cas où ces conditions ne peuvent être satisfaites (pour certaines configurations ou de co-implantation avec un autre émetteur), puis la FCC et Industrie autorisations Canada ne sont plus considérés comme valides et l'ID de la FCC et IC numéro de certification ne peut pas être utilisé sur la produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'un distincte de la FCC et Industrie Canada l'autorisation.

End Product Labelling

The SiFLEX01 Module is labeled with its own FCC ID and IC Certification Number. If the FCC ID and IC Certification Number are not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

“Contains Transmitter Module FCC ID: TFB-SISEN1”

“Contains Transmitter Module IC: 5969A-SISEN1”

or

“Contains FCC ID: TFB-SISEN1”

“Contains IC: 5969A-SISEN1”

The OEM of the SiFLEX01 Module must only use the approved antenna(s) listed above, which have been certified with this module.

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end product.

The user manual for the end product must include the following information in a prominent location:

This device is granted for use in Mobile only configurations in which the antennas used for this transmitter must be installed to provide a separation distance of at least 20cm from all person and not be co-located with any other transmitters except in accordance with FCC and Industry Canada multi-transmitter product procedures.

Le SiFLEX01 Module est étiqueté avec sa propre ID de la FCC et IC numéro de certification. Si l'ID de la FCC et IC numéro de certification ne sont pas visibles lorsque le module est installé à l'intérieur d'un autre appareil, puis l'extérieur de l'appareil dans lequel le module est installé doit également afficher une étiquette mentionnant le module ci-joint. Dans ce cas, le produit final doivent être étiquetés dans un endroit visible de ce qui suit:

Module émetteur Contient FCC ID: TFB-SISEN1

Module émetteur Contient IC: 5969A-SISEN1

ou

Contient FCC ID: TFB-SISEN1

Contient IC: 5969A-SISEN1

Le constructeur d'équipements de l' SiFLEX01 module ne doit utiliser l'antenne approuvée (s) ci-dessus, qui ont été certifiés avec ce module.

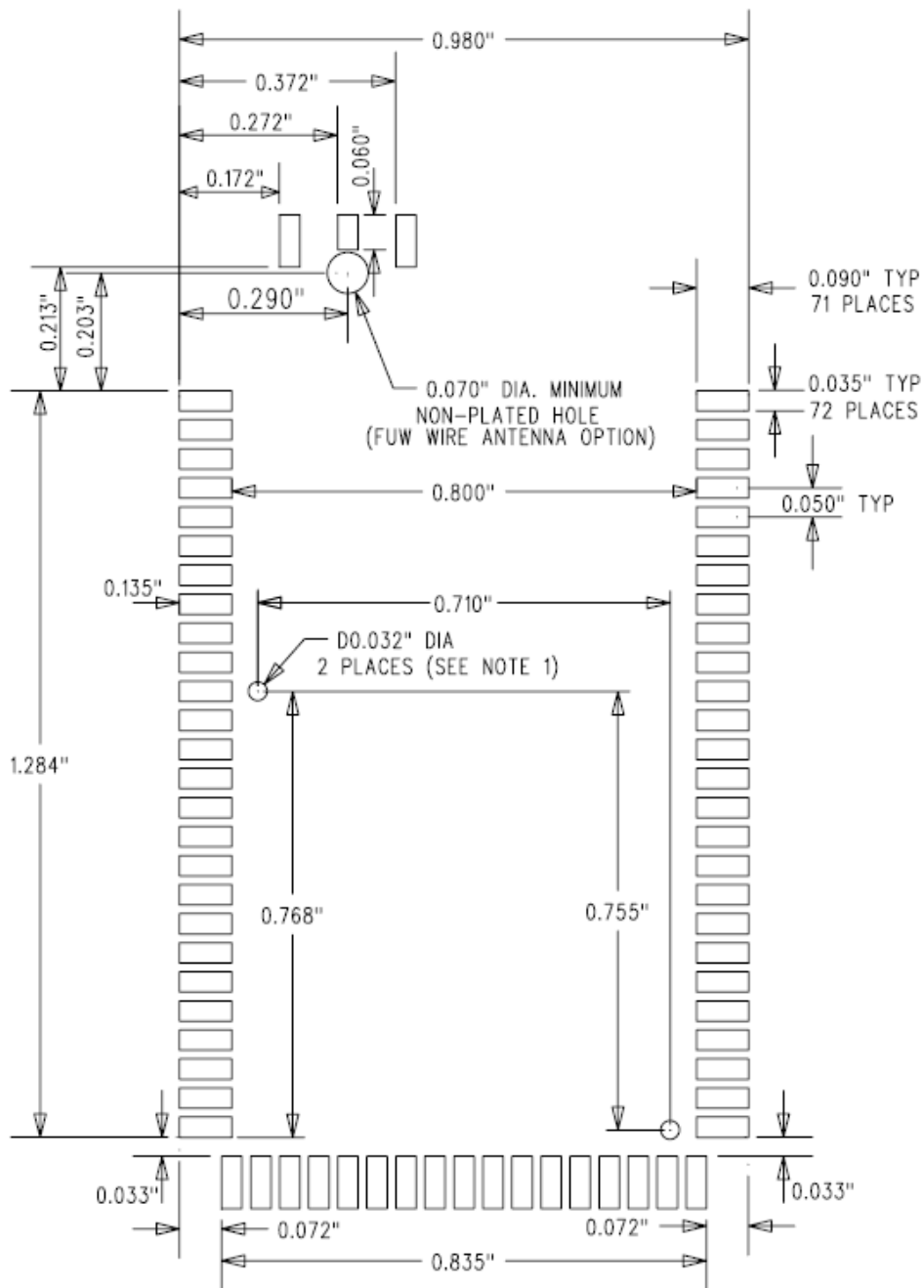
L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF ou RF changer les paramètres liés au mode d'emploi du produit final.

Le manuel d'utilisation pour le produit final doit comporter les informations suivantes dans un endroit bien en vue:

Ce dispositif est accordé pour une utilisation dans des configurations mobiles seule dans laquelle les antennes utilisées pour cet émetteur doit être installé pour fournir une distance de séparation d'au moins 20cm de toute personne et ne pas être co-localisés avec les autres émetteurs, sauf en conformité avec FCC et Industrie Canada, multi-émetteur procédures produit.

MECHANICAL DATA

PCB Footprint



NOTES:

- 1 - OPTIONAL ALIGNMENT HOLES ARE FOR USE WITH FIXTURED PLACEMENT AND HAND SOLDERING OPERATIONS.
- 2 - SEE SiFLEX02 MODULE USER'S GUIDE SFLX-UG-0002 FOR ADDITIONAL INFORMATION

Figure 7 PCB Footprint

General Module Dimensions

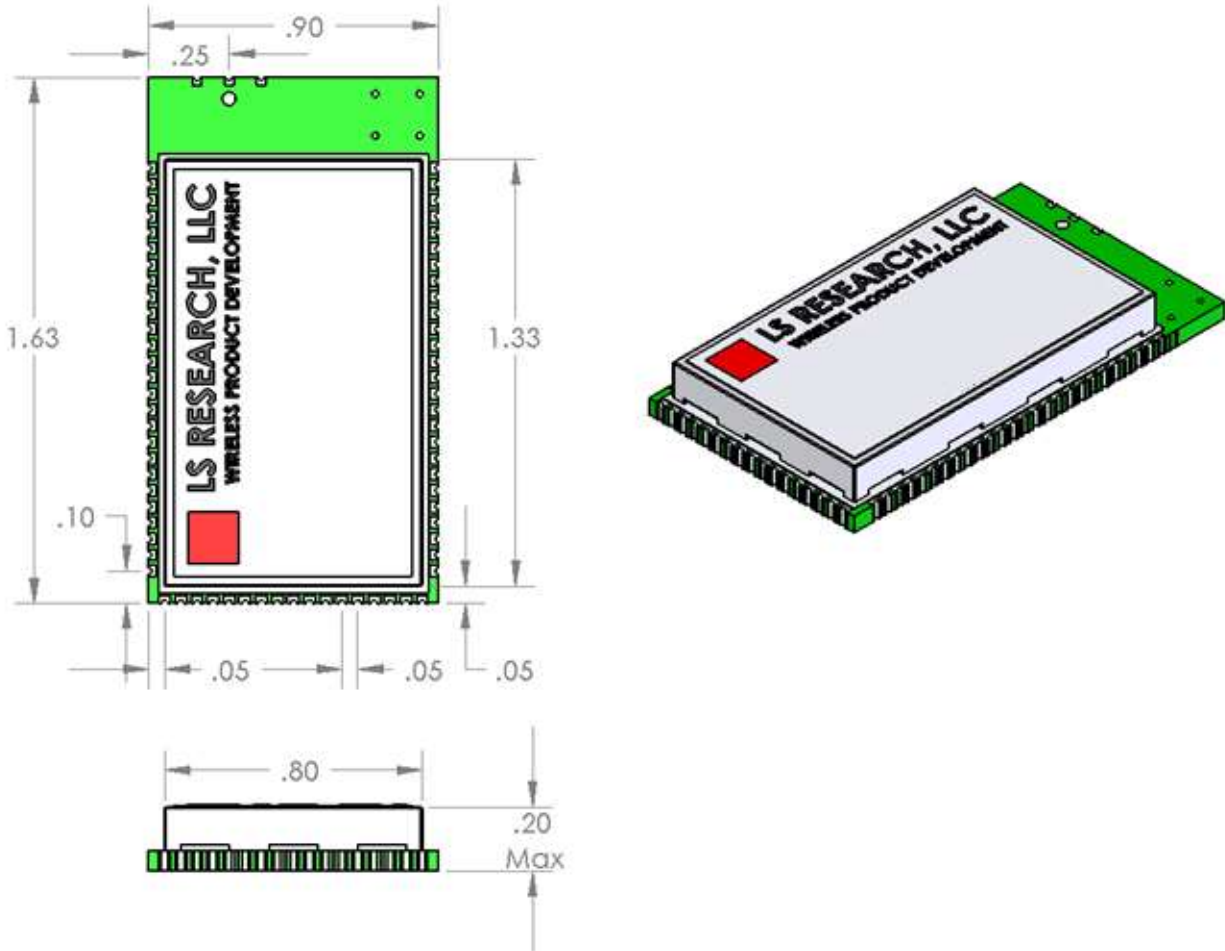


Figure 8 Basic dimensions

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