HT66F03T3/HT68F03T3
8-Bit Flash MCU with RF Transmitter

HOLTEK

Features

MCU Features

- MCU operating voltage with RF Transmitter:
  f_{SYS}= 8MHz: 2.2V~3.6V
  f_{SYS}= 12MHz: 2.7V~3.6V
- Up to 0.33μs instruction cycle with 12MHz system clock
- Power Down and Wake-up functions to reduce power consumption
- Five oscillators:
  - External High Speed Xtal
  - External 32.768kHz Xtal
  - External RC
  - Internal High Speed - no external components
  - Internal 32kHz - no external components
- Multi-mode operation: NORMAL, SLOW, IDLE and SLEEP
- Fully integrated internal 4MHz, 8MHz and 12MHz Oscillator
- All instructions executed in one or two instruction cycles
- Table read instructions
- 63 powerful instructions
- Up to 4 subroutine nesting levels
- Bit manipulation instruction
- Flash Program Memory: 1K×14
- RAM Data Memory: 64×8
- EEPROM Memory: 64×8
- Watchdog Timer function
- Up to 8 bidirectional I/O lines
- External interrupt pin shared with I/O pin
- Multiple Timer Modules for time measure, input capture, compare match output, PWM output or single pulse output functions
- Comparator function
- Dual Time-Base functions for generation of fixed time interrupt signal
- Low voltage reset function
- Low voltage detect function
- Multi-channel 12-bit resolution A/D converter
- Package type: 16-pin NSOP

RF Transmitter Features

- Complete UHF ASK/OOK transmitter
- Frequency range 300MHz to 450MHz
- Data rates more than 10k bps
- Output Power up to 10dBm
- Low voltage operation - down to 2.2V
- Data tracking function for power saving
- Reference clock output for MCU IRC clock synchronisation

General Description

These devices provide a combination of a fully featured MCU plus an RF transmitter function, giving them great flexibility for use in wide range of wireless I/O control applications such as industrial control, consumer products, subsystem controllers, etc.

Analog features include a multi-channel 12-bit A/D converter. Multiple and extremely flexible Timer/Event Counters provide full timing functions. Protective features such as an internal Watchdog Timer and Low Voltage Reset coupled with excellent noise immunity and ESD protection ensure that reliable operation is maintained in hostile electrical environments. An extensive choice of oscillator functions are provided including a fully integrated system oscillator which requires no external components for its implementation. The ability to operate and switch dynamically between a range of operating modes using different clock sources gives users the ability to optimise microcontroller operation and minimise power consumption. The devices also include flexible I/O programming features Time-Base functions and a range of other features.

The RF transmitter is a high performance and easy to use transmitter operating in the 300MHz to 450MHz frequency band. One only needs to add a crystal reference frequency, and a limited number of external components to create a complete and versatile RF transmitter system. The device is capable of delivering more than +9 dBm into a 50Ω load. Such a power level enables a small form factor transmitter to operate near the maximum limit of the transmission regulations. The device can operate with ASK - Amplitude Shift Keying, and OOK - On-Off Keying, UHF receiver types from wide-band super-regenerative radios to narrow-band, high performance super-heterodyne receivers. The data rate is higher than 10kbps, allowing the device to support more complicated control protocols.

For enhanced power saving, the device includes a data tracking function. The data tracking function enables the PLL to be activated as long as high transient data input trigger signals are received. The PLL will also be automatically switched off if there are no data input transients for a time exceeding approximately 300ms. As the RF Transmitter will also generate a synchronising signal, the MCU can use its internal RC clock rather than using an additional crystal for the MCU system clock. These features add up to ensure that the devices can offer excellent capabilities in terms of functionality and power-saving as well as being highly cost effective in a huge range of remote wireless applications

Selection Guide

Most features are common to all devices, the main feature distinguishing them are Memory capacity and A/D converter. The following table summarises the main features of each device.

| Part No.	Program Memory	Data Memory	Data EEPROM	I/O	External Interrupt	A/D Converter	Timer Module	Comparator	RF Transmitter	Stack	Package
HT68F03T3	1K×14	64×8	64×8	7	1	—	10-bit CTM×1 10-bit STM×1	—	√	4	16NSOP
HT66F03T3	1K×14	64×8	64×8	7	1	12-bit×4	10-bit CTM×1 10-bit STM×1	12-bit×4	√	4	16NSOP

Block Diagram

The following block diagram illustrates the dual-chip structure of the devices, where an individual MCU and RF Transmitter devices are combined into a single package.
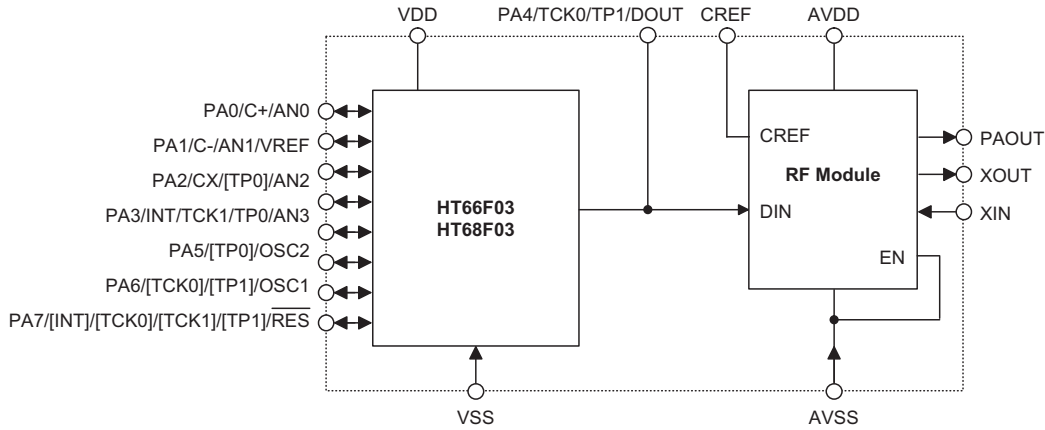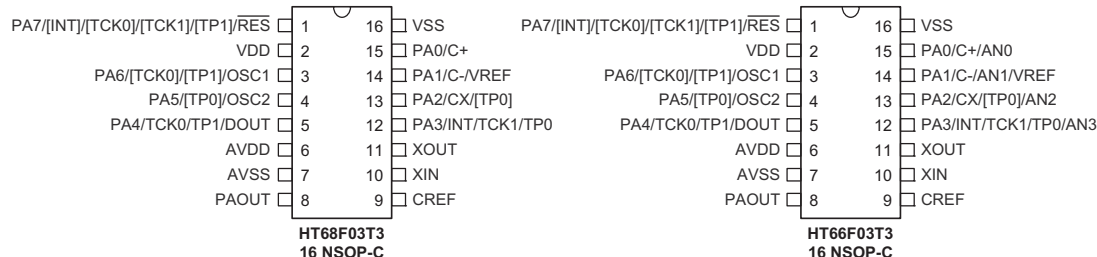

Internal Chip Interconnection Diagram

Note: The AN0~AN3 and VREF shared-pin functions only exist in the HT66F03T3 device.
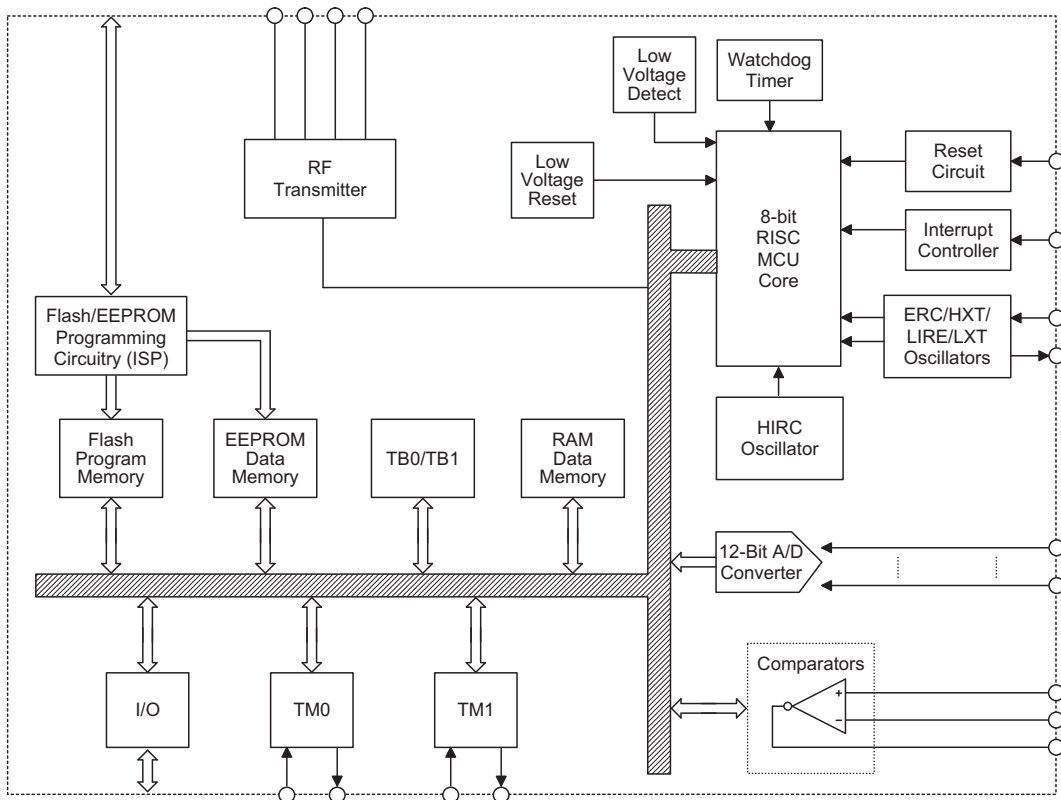
Note: The A/D Converter function only exists in the HT66F03T3 device.

Pin Assignment

```
PA7/[INT]/[TCK0]/[TCK1]/[TP1]/RES  1      16  VSS
                        VDD        2      15  PA0/C+
         PA6/[TCK0]/[TP1]/OSC1     3      14  PA1/C-/VREF
              PA5/[TP0]/OSC2       4      13  PA2/CX/[TP0]
          PA4/TCK0/TP1/DOUT        5      12  PA3/INT/TCK1/TP0
                        AVDD       6      11  XOUT
                        AVSS       7      10  XIN
                       PAOUT       8       9  CREF

                         HT68F03T3
                         16 NSOP-C
```

```
PA7/[INT]/[TCK0]/[TCK1]/[TP1]/RES  1      16  VSS
                        VDD        2      15  PA0/C+/AN0
         PA6/[TCK0]/[TP1]/OSC1     3      14  PA1/C-/AN1/VREF
              PA5/[TP0]/OSC2       4      13  PA2/CX/[TP0]/AN2
          PA4/TCK0/TP1/DOUT        5      12  PA3/INT/TCK1/TP0/AN3
                        AVDD       6      11  XOUT
                        AVSS       7      10  XIN
                       PAOUT       8       9  CREF

                         HT66F03T3
                         16 NSOP-C
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Pin Description

HT66F03T3

Pin Name	Function	OP	I/T	O/T	Pin-Shared Mapping
PA0~PA7	Port A	PAWU PAPU	ST	CMOS	—
AN0~AN3	A/D Converter input	ACERL	AN	—	PA0~PA3
VREF	A/D Converter reference input	ADCR1	AN	—	PA1
C-	Comparator input		AN	—	PA1
C+	Comparator input	CPC	AN	—	PA0
CX	Comparator output		—	CMOS	PA2
TCK0	TM0 input	PRM	ST	—	PA4, PA6 or PA7
TCK1	TM1 input	PRM	ST	—	PA3 or PA7
TP0	TM0 I/O	PRM	ST	CMOS	PA3, PA5 or PA2
TP1	TM1 I/O	PRM	ST	CMOS	PA4, PA6 or PA7
INT	External interrupt	PRM	ST	—	PA3 or PA7
OSC1	HXT/ERC/LXT pin	CO	HXT/LXT	—	PA6
OSC2	HXT/LXT pin	CO	—	HXT/LXT	PA5
RES	Reset input	CO	ST	—	PA7
VDD	MCU power supply	—	PWR	—	—
VSS	MCU ground	—	PWR	—	—
PAOUT	RF power amplifier output	—	PWR	NSO	—
DOUT	Data Output	PAWU PAPU	ST	CMOS	PA4
CREF	RF transmitter synnchronising signal	—	—	CMOS	—
XOUT	RF transmitter crystal pin	—	—	HXT	—
XIN	RF transmitter crystal pin	—	HXT	—	—
AVDD	RF transmitter power supply	—	PWR	—	—
AVSS	RF transmitter ground	—	PWR	—	—

Note: I/T: Input type; O/T: Output type

OP: Optional by configuration option (CO) or register option

PWR: Power; CO: Configuration option; ST: Schmitt Trigger input; NS: non-standard input

CMOS: CMOS output; NMOS: NMOS output

SCOM: Software controlled LCD COM; AN: Analog input pin

HXT: High frequency crystal oscillator

LXT: Low frequency crystal oscillator

NSO: Non-standard output

HT68F03T3

Pin Name	Function	OP	I/T	O/T	Pin-Shared Mapping
PA0~PA7	Port A	PAWU PAPU	ST	CMOS	—
C-	Comparator input		AN	—	PA1
C+	Comparator input	CPC	AN	—	PA0
CX	Comparator output		—	CMOS	PA2
TCK0	TM0 input	PRM	ST	—	PA4, PA6 or PA7
TCK1	TM1 input	PRM	ST	—	PA3 or PA7
TP0	TM0 I/O	PRM	ST	CMOS	PA3, PA5 or PA2
TP1	TM1 I/O	PRM	ST	CMOS	PA4, PA6 or PA7
INT	External interrupt	PRM	ST	—	PA3 or PA7
OSC1	HXT/ERC/LXT pin	CO	HXT/LXT	—	PA6
OSC2	HXT/LXT pin	CO	—	HXT/LXT	PA5
$\overline{RES}$	Reset input	CO	ST	—	PA7
VDD	MCU power supply	—	PWR	—	—
VSS	MCU ground	—	PWR	—	—
PAOUT	RF power amplifier output	—	PWR	NSO	—
DOUT	Data Output	PAWU PAPU	ST	CMOS	PA4
CREF	RF transmitter synnchronising signal	—	—	CMOS	—
XOUT	RF transmitter crystal pin	—	—	HXT	—
XIN	RF transmitter crystal pin	—	HXT	—	—
AVDD	RF transmitter power supply	—	PWR	—	—
AVSS	RF transmitter ground	—	PWR	—	—

Note: I/T: Input type; O/T: Output type
　　　　OP: Optional by configuration option (CO) or register option
　　　　PWR: Power; CO: Configuration option; ST: Schmitt Trigger input; NS: non-standard input
　　　　CMOS: CMOS output; NMOS: NMOS output
　　　　SCOM: Software controlled LCD COM; AN: Analog input pin
　　　　HXT: High frequency crystal oscillator
　　　　LXT: Low frequency crystal oscillator
　　　　NSO: Non-standard output

D.C. Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage (HXT, ERC, HIRC)	—	f_{SYS}=8MHz	2.2	—	3.6	V
			f_{SYS}=12MHz	2.7	—	3.6	V
AV_{DD}	RF Transmitter Power Supply	—	—	2.0	—	3.6	V
I_{DD}	Operating Current (HIRC)	3V	No load, f_{SYS}=8MHz, ADC disable, WDT enable	—	1.2	2.0	mA
		3V	No load, f_{SYS}=12MHz, ADC disable, WDT enable	—	1.8	3.0	mA
I_{STB}	Standby Current (Idle) (LIRC), (f_{SYS}=off, f_S=f_{SUB}=f_{LIRC})	3V	No load, system HALT, f_{SYS}=32768Hz	—	1.3	3.0	μA
V_{IL1}	Input Low Voltage for I/O Ports, TCKx and INT	—	—	0	—	$0.3V_{DD}$	V
V_{IH1}	Input High Voltage for I/O Ports, TCKx and INT	—	—	$0.7V_{DD}$	—	V_{DD}	V
V_{IL2}	Input Low Voltage ($\overline{RES}$)	—	—	0	—	$0.4V_{DD}$	V
V_{IH2}	Input High Voltage ($\overline{RES}$)	—	—	$0.9V_{DD}$	—	V_{DD}	V
V_{LVR1}	Low Voltage Reset	—	LVR Enable, 2.10V option	−5%	2.10	+5%	V
V_{LVR2}		—	LVR Enable, 3.15V option	−5%	3.15	+5%	V
R_{PH}	Pull-high Resistance for I/O Ports	3V	—	20	60	100	kΩ

A.C. Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
f_{SYS}	System Clock (HIRC)	3V	Ta= −40°C~85°C	−15%	—	+5%	MHz
f_{TIMER}	Timer I/P Frequency (TMR)	—	2.2V~3.6V	0	—	8	MHz
		—	2.7V~3.6V	0	—	12	MHz
t_{RES}	External Reset Low Pulse Width	—	—	1	—	—	μs
t_{SST}	System Start-up Timer Period	—	Wake-up from HALT	—	15~16	—	t_{SYS}
t_{LVR}	Low Voltage Width to Reset	—	—	120	240	480	μs

Note: t_{SYS}=1/f_{SYS}

A/D Converter Electrical Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{ADC}	A/D Operating Voltage	—	$V_{REF}=V_{ADC}$	2.7	—	3.6	V
V_{ADI}	A/D Converter Input Voltage	—	—	0	—	V_{REF}	V
V_{REF}	A/D Converter Reference Voltage	—	—	2	—	V_{ADC}	V
t_{ADCK}	A/D Converter Clock Period	2.2V~3.6V	—	0.5	—	10	μs
t_{ADS}	A/D Converter Sampling Time	2.7V / 3V	$V_{REF}=V_{ADC}=V_{DD}$, $t_{AD}=0.5\mu s$ (calculated on best-fit line)	—	4	—	t_{ADCK}

RF Transmitter Electrical Characteristics

Specifications apply for AV_{DD}=3.0V, Ta = 25°C, Freq X′tal OSC=13.560MHz, DATA is transmitting. Bold values indicate -20°C to 70°C unless otherwise noted. 1kbps data rate 50% duty cycle. RL 50Ω load (matched)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		AV_{DD}	Conditions				
I_I	Data High Current	3V	@315MHz, POUT=+10dBm	—	12.5	—	mA
		3V	@433.92MHz	—	12.5	—	mA
I_O	Data Low Current	3V	@315MHz	—	3.0	—	mA
		3V	@433.92 MHz	—	3.0	—	mA
I_{STB}	EN Low & DIN Low Current	3V	@315MHz	—	1.0	—	μA
		3V	@433.92 MHz	—	1.0	—	μA
RF and Crystal							
	Output power level	3.3V	@315MHz *	—	9.5	—	dBm
		3.3V	@433.92MHz *	—	9.5	—	dBm
	Harmonics output for 315 MHz	3V	@630MHz, 2nd harm	—	−48	—	dBc
		3V	@945MHz, 3rd harm	—	−60	—	dBc
	Harmonics Output for 433.92MHz	3V	@867.84MHz, 2nd harm	—	−45	—	dBc
		3V	@1301.76MHz, 3rd harm	—	−55	—	dBc
	Extinction Ratio for ASK 10Kbps	3V	—	—	70	—	dBc
	Data Rate	3V	—	10	—	—	kbps
	Occupied Bandwidth	3V	@315MHz	—	<900	—	kHz
		3V	@433.92MHz	—	<1000	—	kHz
	315MHz Single Side Band Phase Noise	3V	100kHz from Carrier	—	−78	—	dBc/Hz
		3V	1000kHz from Carrier	—	−77	—	dBc/Hz

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		AV$_{DD}$	Conditions				
	433.92MHz Single Side Band Phase Noise	3V	100kHz from Carrier	—	−78	—	dBc/Hz
			1000kHz from Carrier	—	−76	—	dBc/Hz
	XTLIN, XTLOUT	3V	Pin capacitance	—	2	—	pF
	Output Blanking	3V	Standby transition from low to high **	—	500	—	μs
	ASK to RF Out Response Time	3V	Delta between ASK input transition from Low To High to RF output transition from low to high	—	1	—	μs
	CREF Clock Output Frequency	3V	@315MHz	—	150	—	Hz
			@433.92MHz	—	207	—	Hz

Note: * Depend on PC board layout
   ** Generally limited by crystal

Power-on Reset Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V$_{DD}$	Conditions				
V$_{POR}$	VDD Start Voltage to Ensure Power-on Reset	—	—	—	—	100	mV
R$_{POR\,AC}$	VDD Raising Rate to Ensure Power-on Reset	—	—	0.035	—	—	V/ms
t$_{POR}$	Minimum Time for VDD Stays at V$_{POR}$ to Ensure Power-on Reset	—	—	1	—	—	ms
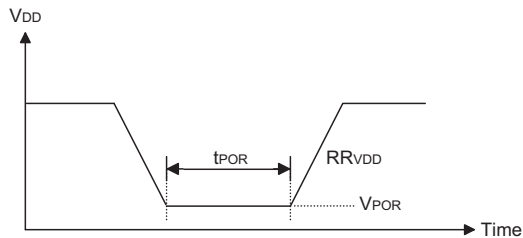
Functional Description

As these device packages contain different chips internally, for a detailed functional description, users must refer to the relevant datasheets for the related MCU. The following table shows which individual devices are inside each package.

Device	MCU
HT66F03T3	HT66F03
HT68F03T3	HT68F03

Multi-chip Internal Devices

One of the MCU I/O pins, PA4, is internally connected to the data input pin, DIN, of RF transmitter chip and should therefore be setup as an output by the MCU. This pin is used to generate the encoding data. There are some special considerations which need to be taken into account when using these devices. These points will be mentioned in the hardware and software consideration sections.

Hardware Considerations

As these devices are composed of an individual MCU and RF Transmitter, using them together requires the user to take care of some special points.

Absolute Maximum Ratings

The Absolute Maximum Ratings must be checked for discrepancies and the necessary care taken in device handling and usage.

Power Supply

Examination of the block diagram will reveal that the Power Supply and Ground pins of the RF Transmitter and MCU are independent and must be connected together if they are to share the same power supply. If the same power supply is to be used for both chips then care must be taken as the maximum power supply voltage of the RF Transmitter is less than the maximum MCU power supply voltage. Also note that higher MCU system clock frequencies may require MCU power supply voltages that exceed the RF Transmitter maximum power supply voltage. For this reason it will not be possible to operate the MCU at its maximum system clock frequency if the MCU shares the same power supply as the RF Transmitter.

When calculating the total current consumption of the device, the specified currents of the MCU part and the RF part in the DC specifications, must be added together. Similarly, the standby current is the sum of the two individual chip standby currents.

Operation

The RF data to be transmitted is derived from the PA4 line. When the PA4 line is high the RF Transmitter will transmit it data allowing users to program their encoded data on this line. If the RF transmitter is in its standby mode then there will be a delay of about 500us before transmission begins. When the device is transmitting, a synchronising signal will be generated on the CREF pin which can be connected externally to an MCU I/O pin for calibration of the MCU internal RC oscillator. To avoid the RF circuits entering an unknown state, pin PA4 should be setup as an output as soon as possible after power-on.

To minimise power consumption, only when PA4 is high, can the RF signal be transmitted and the reference clock on CREF be generated. If no data transitions are generated on PA4 for 300~500ms, the transmitter will enter a standby state and the RF circuits will be switched off along with the internal PLL to save power. The signal generated on the CREF pin will also remain at a low level. The internal PLL function is used to generate the RF frequency with a multiplier of 32 times the crystal frequency. The relationship is: RF frequency = 32 x Crystal frequency. Therefore a 9.84375MHz crystal will

generate an RF frequency of 315MHz and a13.56MHz crystal will generate an RF frequency of 433.92MHz. All PLL circuits are contained within the device and the only external component required is a suitable crystal.

Power Down and Wake up

It is important to note that if the MCU is powered down or placed into a low power mode to conserve power, that the RF Transmitter may continue running and will consume a certain amount of power. Before powering down the MCU it is important to carefully manage the PA4 pin to ensure the RF-Transmitter enters its power down state.

Unbonded MCU pins

Examination of the relevant MCU datasheet will reveal that not all of the MCU I/O port lines are bonded out to external pins. As a result special attention regarding initialisation procedures should be paid to these port lines. Users should therefore ensure that these I/O pins are setup as inputs with pull high resistors or as outputs to avoid additional power consumption resulting from floating input pins.

Programming Considerations

As MCU I/O pin PA4 is used to control the RF transmitter function, care must be taken to manage this pin correctly in the application program. As line PA4 is used to send data to the RF circuitry this multi-function pin line must be correctly setup to function as logic output. To avoid erroneous operation of the RF circuits this line should be setup as an output immediately after power-on.

If the CREF pin is connected externally to an MCU I/O pin for synchronisation purposes, then this pin must be properly setup as a logic input immediately after power on.

As the MCU will be powered down independently of the RF Transmitter Peripheral Module, care must be taken to ensure that the MCU first clears its PA4 line to zero before powering down. This will allow the RF Transmitter Peripheral Module to enter its standby state and thus keep power consumption to a minimum.

Application Circuits
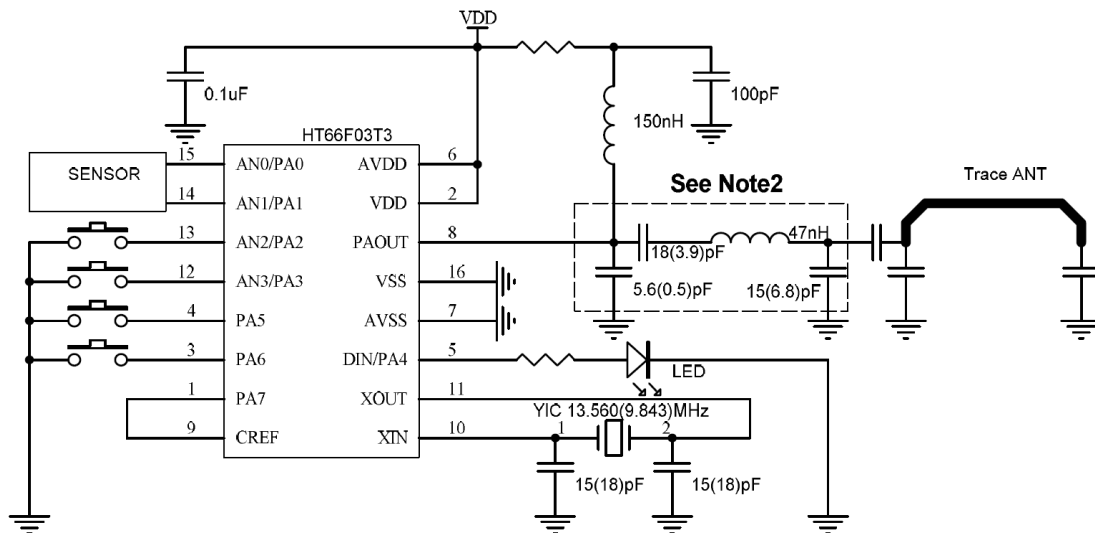
Note:
1. A 9.84375MHz crystal is used for an RF frequency of 315MHz
   A 13.56MHz crystal is used for an RF frequency of 433.92MHz
2. The extra LC filter on the PAOUT pin can reduce second order harmonics
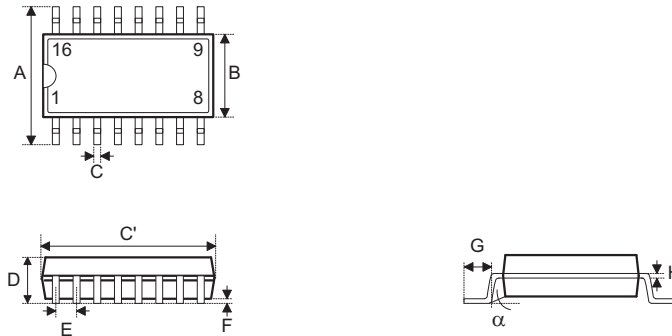3. The bracketed L and C values are for 433.92MHz operation

Package Information

16-pin NSOP (150mil) Outline Dimensions

MS-012

Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.228	—	0.244
B	0.150	—	0.157
C	0.012	—	0.020
C′	0.386	—	0.402
D	—	—	0.069
E	—	0.050	—
F	0.004	—	0.010
G	0.016	—	0.050
H	0.007	—	0.010
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	5.79	—	6.20
B	3.81	—	3.99
C	0.30	—	0.51
C′	9.80	—	10.21
D	—	—	1.75
E	—	1.27	—
F	0.10	—	0.25
G	0.41	—	1.27
H	0.18	—	0.25
α	0°	—	8°

Reel Dimensions
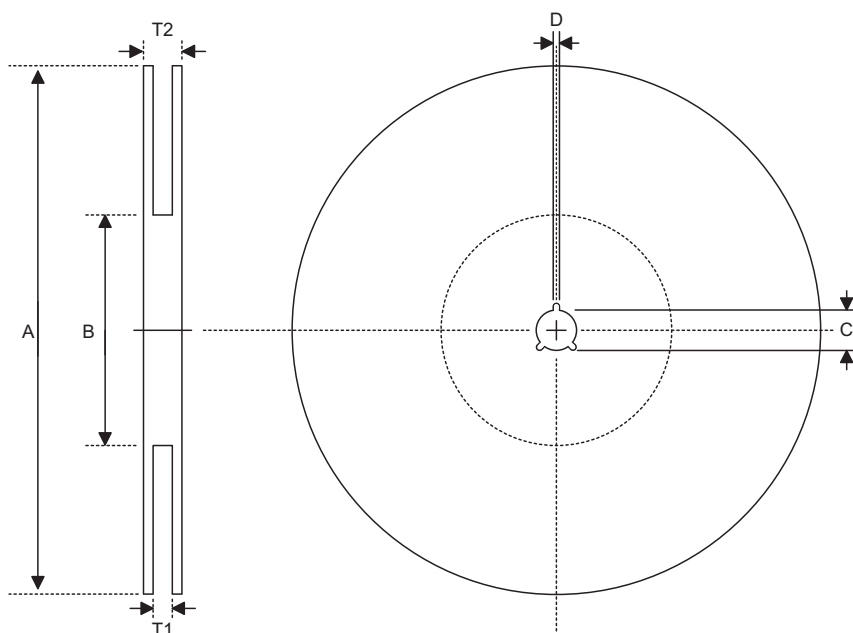
SOP 16N (150mil)

Symbol	Description	Dimensions in mm
A	Reel Outer Diameter	330.0±1.0
B	Reel Inner Diameter	100.0±1.5
C	Spindle Hole Diameter	13.0 $^{+0.5/-0.2}$
D	Key Slit Width	2.0±0.5
T1	Space Between Flange	16.8 $^{+0.3/-0.2}$
T2	Reel Thickness	22.2±0.2

Carrier Tape Dimensions

Reel Hole

IC package pin 1 and the reel holes are located on the same side.
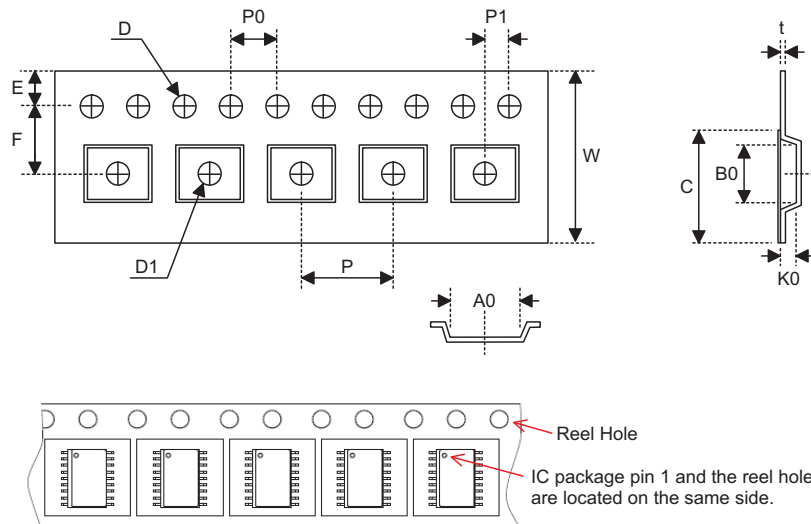
SOP 16N (150mil)

Symbol	Description	Dimensions in mm
W	Carrier Tape Width	16.0±0.3
P	Cavity Pitch	8.0±0.1
E	Perforation Position	1.75±0.1
F	Cavity to Perforation (Width Direction)	7.5±0.1
D	Perforation Diameter	1.55 $^{+0.10/-0.00}$
D1	Cavity Hole Diameter	1.50 $^{+0.25/-0.00}$
P0	Perforation Pitch	4.0±0.1
P1	Cavity to Perforation (Length Direction)	2.0±0.1
A0	Cavity Length	6.5±0.1
B0	Cavity Width	10.3±0.1
K0	Cavity Depth	2.1±0.1
t	Carrier Tape Thickness	0.30±0.05
C	Cover Tape Width	13.3±0.1