HT46R01T3/ HT48R01T3

8-Bit OTP MCU with RF Transmitter

Features

MCU Features

- MCU Operating voltage:
  f_{SYS}= 4MHz: 2.2V~3.6V
  f_{SYS}= 8MHz: 3.0V~3.6V
- Power Down modes and wake-up functions to reduce power consumption
- Oscillator types
  - External high frequency Crystal
  - External RC
  - Internal RC
  - External low frequency crystal
  - Watchdog Timer Internal RC Oscillator
- Three operational modes: Normal, Slow, Sleep
- Fully integrated internal 4MHz, 8MHz oscillator requires no external components
- OTP Program Memory: 1K×15
- RAM Data Memory: 96×8
- Watchdog Timer function
- All instructions executed in one or two instruction cycles
- Table read instructions
- 63 powerful instructions
- 6-level subroutine nesting
- Bit manipulation instruction
- Low voltage reset function
- 16-pin NSOP package type
- Up to 8 bidirectional I/O lines
- 4 channel 12-bit ADC
- 1 channel 8-bit PWM
- External interrupt input shared with an I/O line
- Two 8-bit programmable Timer/Event Counter with overflow interrupt and prescaler
- Time-Base function
- Programmable Frequency Divider - PFD

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 +9dBm 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.

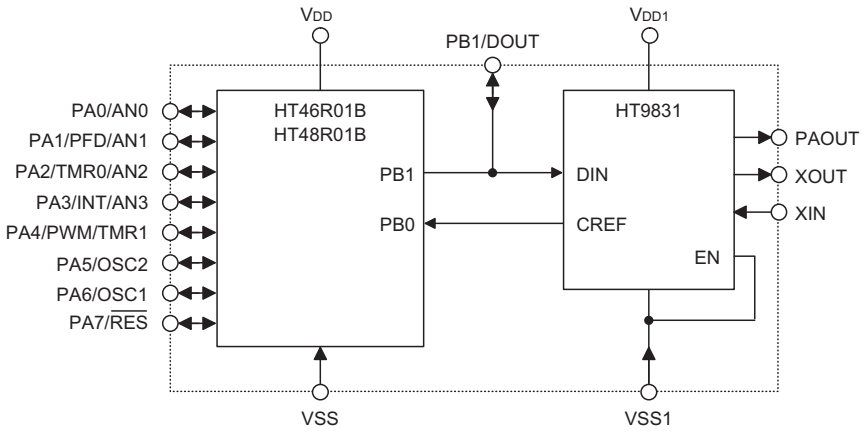
For enhanced power saving, the device includes a data tracking function. The data tracking function enables the PLL to be activated as long as high transient data input trigger signals are received. The PLL will also be automatically switched off if there are no data input transients for a time exceeding approximately 300ms. As there is a reference clock input on line PB0, the MCU can use its internal RC clock rather than using an additional crystal for the 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

Part No.	Program Memory	Data Memory	I/O	8-bit Timer	Time Base	RF Transmitter	A/D	PWM	Stack	Package
HT48R01T3	1K×15	96×8	9	2	1	√	—	—	6	16NSOP
HT46R01T3	1K×15	96×8	9	2	1	√	12-bit×4	8-bit×1	6	16NSOP

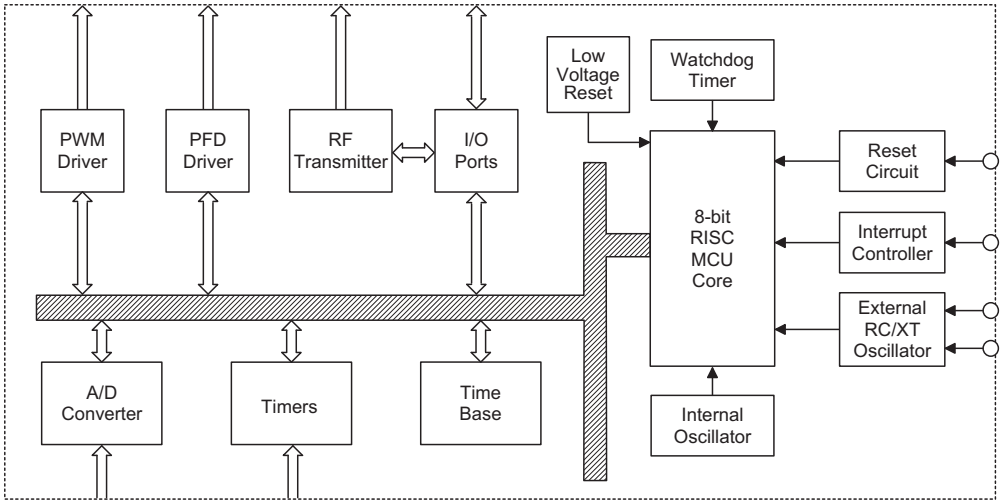
Block Diagram

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.



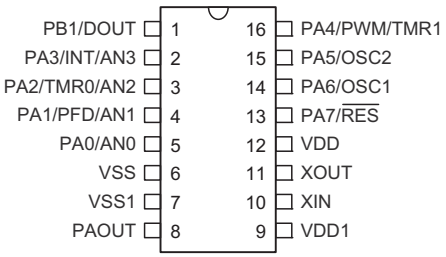
Internal Chip Interconnection Diagram

Note: The PWM and AN0~AN3 shared-pin functions only exist in the HT46R01T3 device.

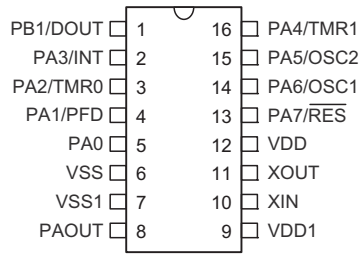


Note: The PWM and A/D Converter functions only exist in the HT46R01T3 device.

Pin Assignment



HT46R01T3
16 NSOP-C



HT48R01T3
16 NSOP-C

Pin Description

HT46R01T3

Pin Name	Function	OPT	I/T	O/T	Description
PA0/AN0	PA0	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	AN0	ADCR	AN	—	A/D channel 0
PA1/PFD/AN1	PA1	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	PFD	CTRL0	—	CMOS	PFD output
	AN1	ADCR	AN	—	A/D channel 1
PA2/TMR0/AN2	PA2	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	TC0	—	ST	—	External Timer 0 clock input
	AN2	ADCR	AN	—	A/D channel 2
PA3/INT/AN3	PA3	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	INT	—	ST	—	External interrupt input
	AN3	ADCR	AN	—	A/D channel 3
PA4/TMR1/PWM	PA4	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	TC1	—	ST	—	External Timer 1 clock input
	PWM	CTRL0	—	CMOS	PWM output
PA5/OSC2	PA5	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	OSC2	CO	—	OSC	Oscillator pin
PA6/OSC1	PA6	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	OSC1	CO	OSC	—	Oscillator pin
PA7/$\overline{\text{RES}}$	PA7	PAWK	ST	NMOS	General purpose I/O. Register enabled wake-up.
	$\overline{\text{RES}}$	CO	ST	—	Reset input
PB1/DOUT	PB1	PBPU	ST	CMOS	General purpose I/O. Register enabled pull-up. Internally connected to DIN pin on RF module. Must be setup as output for interfacing to RF module.
	DOUT	—	—	—	Data output from MCU to RF module Connected internally to PB1

Pin Name	Function	OPT	I/T	O/T	Description
PAOUT	PAOUT	—	—	NSO	RF power amplifier output
XOUT	XOUT	—	—	HXT	RF chip crystal pin
XIN	XIN	—	HXT	—	RF chip crystal pin
VDD	VDD	—	PWR	—	MCU power supply
VSS	VSS	—	PWR	—	MCU ground
VDD1	VDD1	—	PWR	—	RF chip power supply
VSS1	VSS1	—	PWR	—	RF chip ground

Note: I/T: Input type
O/T: Output type
OPT: Optional by configuration option (CO) or register option
PWR: Power
CO: Configuration option
ST: Schmitt Trigger input
CMOS: CMOS output
NSO: Non-standard output

HT48R01T3

Pin Name	Function	OPT	I/T	O/T	Description
PA0	PA0	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
PA1/PFD	PA1	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	PFD	CTRL0	—	CMOS	PFD output
PA2/TMR0	PA2	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	TC0	—	ST	—	External Timer 0 clock input
PA3/INT	PA3	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	INT	—	ST	—	External interrupt input
PA4/TMR1	PA4	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	TC1	—	ST	—	External Timer 1 clock input
PA5/OSC2	PA5	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	OSC2	CO	—	OSC	Oscillator pin
PA6/OSC1	PA6	PAPU PAWK	ST	CMOS	General purpose I/O. Register enabled pull-up and wake-up.
	OSC1	CO	OSC	—	Oscillator pin
PA7/$\overline{\text{RES}}$	PA7	PAWK	ST	NMOS	General purpose I/O. Register enabled wake-up.
	$\overline{\text{RES}}$	CO	ST	—	Reset input
PB1/DOUT	PB1	PBPU	ST	CMOS	General purpose I/O. Register enabled pull-up. Internally connected to DIN pin on RF module. Must be setup as output for interfacing to RF module.
	DOUT	—	—	—	Data output from MCU to RF module Connected internally to PB1

Pin Name	Function	OPT	I/T	O/T	Description
PAOUT	PAOUT	—	—	NSO	RF power amplifier output
XOUT	XOUT	—	—	HXT	RF chip crystal pin
XIN	XIN	—	HXT	—	RF chip crystal pin
VDD	VDD	—	PWR	—	MCU power supply
VSS	VSS	—	PWR	—	MCU ground
VDD1	VDD1	—	PWR	—	RF chip power supply
VSS1	VSS1	—	PWR	—	RF chip ground

Note: I/T: Input type
O/T: Output type
OPT: Optional by configuration option (CO) or register option
PWR: Power
CO: Configuration option
ST: Schmitt Trigger input
CMOS: CMOS output
NSO: Non-standard output

Internally Connected Pins

In addition to the internal connection between MCU pin, PB1, and RF Transmitter pin, DIN, the MCU pin, PB0, and RF Transmitter pin, CREF, are also internally connected. However it should be noted that PB0/CREF is not connected to any external pins on the device package.

Pin Name	Function	OPT	I/T	O/T	Description
PB0/CREF	PB0	PBPU	ST	CMOS	General Purpose I/O. Register enabled pull-high resistor. Internally connected to CREF pin on RF module. Must be setup as an input for interfacing to RF module. Not available on package.
	CREF	—	—	—	RF Transmitter generated pulses for synchronisation. Connected internally to PB0. Not available on package.

Functional Description

As these device packages contain multiple internal chips, for a detailed functional description, users must refer to the relevant individual datasheets for both the MCU and the RF Transmitter. The following table shows which individual devices are inside each package.

Device	MCU	RF Transmitter
HT48R01T3	HT48R01B	HT9831
HT46R01T3	HT46R01B	HT9831

Multi-chip Internal Devices

The MCU controls the RF transmitter via a two line interface using two of its I/O pins, PB0 and PB1. Pin PB1, which should be setup as an output by the MCU, is used to generate the encoding data. Pin PB0, which should be setup as an input by the MCU, is used for synchronising purposes. Although most of the functional description material will be located in the individual datasheets, there are some special considerations which need to be taken into account when using multi-chip devices. These points will be mentioned in the hardware and software consideration sections.

Multi-chip Hardware Considerations

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

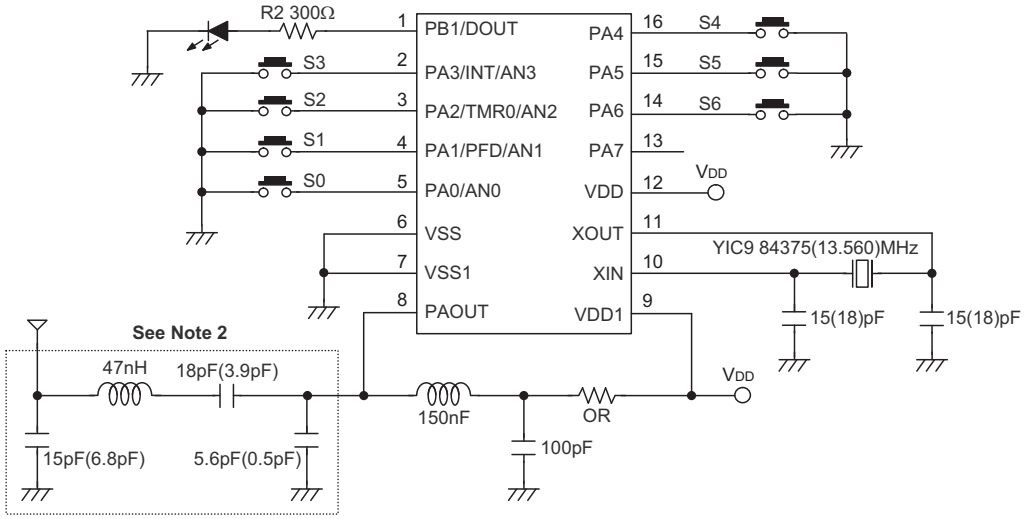
- Absolute Maximum Ratings
  The Absolute Maximum Ratings for the two individual chips must be checked for discrepancies and the necessary care taken in device handling and usage.
- Power Supply
  Examination of the block diagram will reveal that the Power Supply and Ground pins of the RF Transmitter 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 both have different power supply requirements.
  When calculating the total current consumption of the device, the internal DC specifications of the two internal chips must be consulted and the individual currents added together.
- Operation
  When examining the datasheet of the HT9831 RF Transmitter device, it can be seen that there is an EN pin on the device. This EN pin is not bonded out to an external pin on the packages of the HT46R01T3/HT48R01T3 but is internally connected to the VSS1 ground pin. Therefore when reading the HT9831 datasheet users must take into account the permanent low state of the EN pin.
  The RF data to be transmitted is derived from the PB1 line. When the PB1 line is high the device will transmit 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 500μs before transmission begins. When the device is transmitting, a synchronising signal will be generated on the CREF/PB0 pin which allows the MCU to use it to calibrate its internal RC oscillator. To avoid the RF circuits entering an unknown state, pin PB1 should be setup as an output as soon as possible after power-on.
  To minimise power consumption, only when PB1 is high, can the RF signal be transmitted and the reference clock on PB0 be generated. If no data transitions are generated on PB1 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/PB0 line 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 × 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 PB1 pin to ensure the RF-Transmitter enters its power down state.

Multi-chip Programming Considerations

As MCU lines PB0 and PB1 are used to control the RF transmitter function, care must be taken to manage these lines correctly in the application program. As line PB1 is used to send data to the RF circuitry this line must be setup as an output. To avoid erroneous operation of the RF circuits this line should be setup as an output immediately after power-on. The PB0 pin on the MCU is used to receive synchronising pulses from the RF circuits and should therefore be setup as an input.

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 PB1 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.

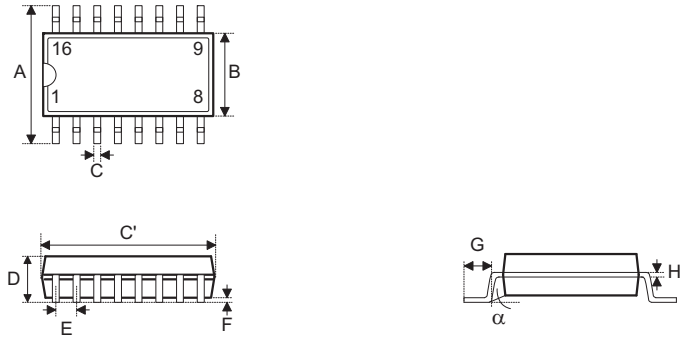
Application Circuits



Note: 1. 9.84375MHz crystal used for RF frequency of 315MHz
13.56MHz crystal used for RF frequency of 433.92MHz
2. The extra RC filter on the PAOUT pin can reduce second harmonics
3. The L and C values shown in brackets are for 433.92MHz

Package Information

16-pin NSOP (150mil) Outline Dimensions



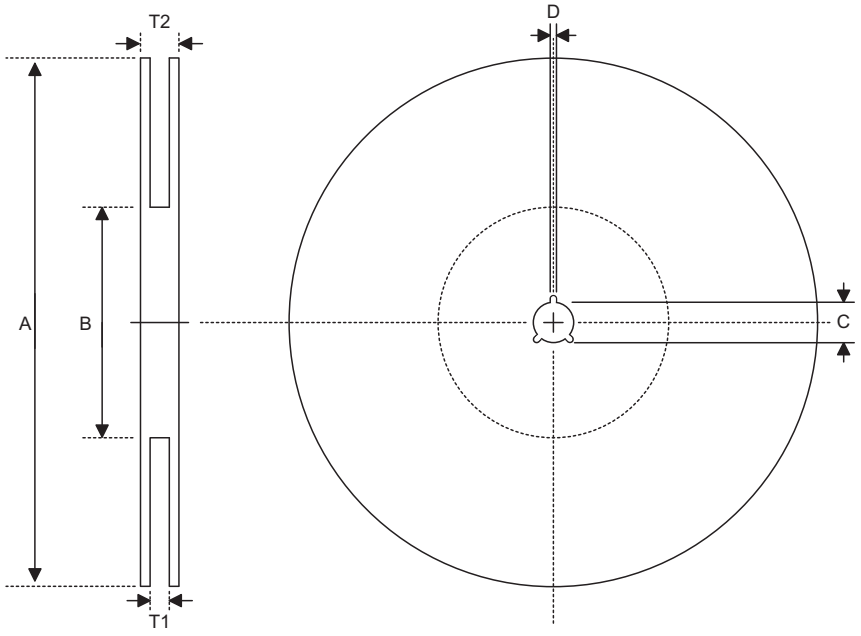
• MS-012

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	—	0.394
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	—	10.01
D	—	—	1.75
E	—	1.27	—
F	0.10	—	0.25
G	0.41	—	1.27
H	0.18	—	0.25
α	0°	—	8°

Product Tape and Reel Specifications

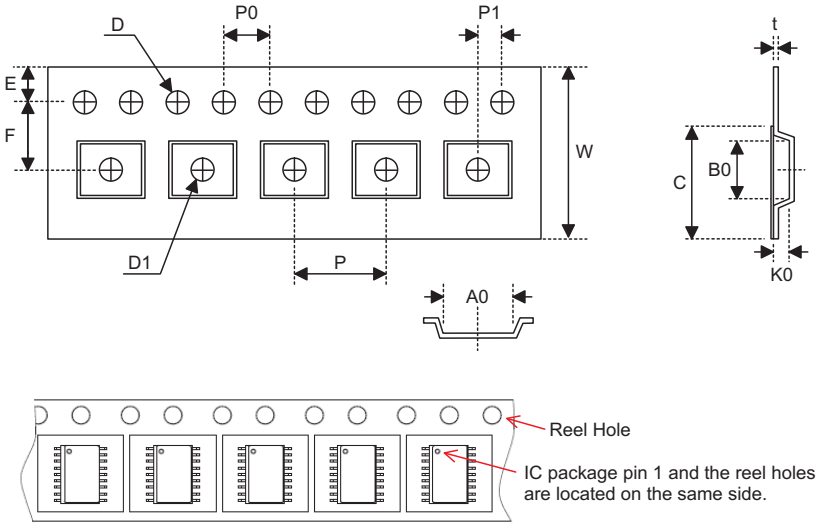
Reel Dimensions



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



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

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