Infrared Remote Controller Workshop
User Guide

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www.holtek.com

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1. Introduction

The Holtek Infrared Remote Controller Workshop is a design software for fast design of infrared remote controllers. The software not only supports remote controller software development based on general standard protocols, such as NEC, NEC-16, Philips RC-5, Philips RC-6, Sharp and other common remote controller protocols, but also provides a design method for users to define their own infrared remote code parameters which are different from other standard protocols. In addition, together with the Holtek IR decoder board, the workshop can analyse IR waveforms for existing remote controllers. This can then be used for new remote controller development based on the same protocol or used to verify the sending code for remote controllers under development.

The main application functions for common infrared remote controllers are divided into the following categories:

1. General remote controllers

   Keys: identify user actions.

   Code modulation: use different code protocols to modulate signals to avoid interference between different receiver devices.

   Indicators: sending code indication.

   Static power control: extend battery life.

2. LCD remote controllers

   Keys: identify user actions.

   Code modulation: use different code protocols to modulate signals to avoid interference between different receiver devices.

   LCD display: display various operation status information that the remote controller sends to the receiver device.

   Backlight: LCD backlight driver.

   Static power control: extend battery life.

2. Workshop Software

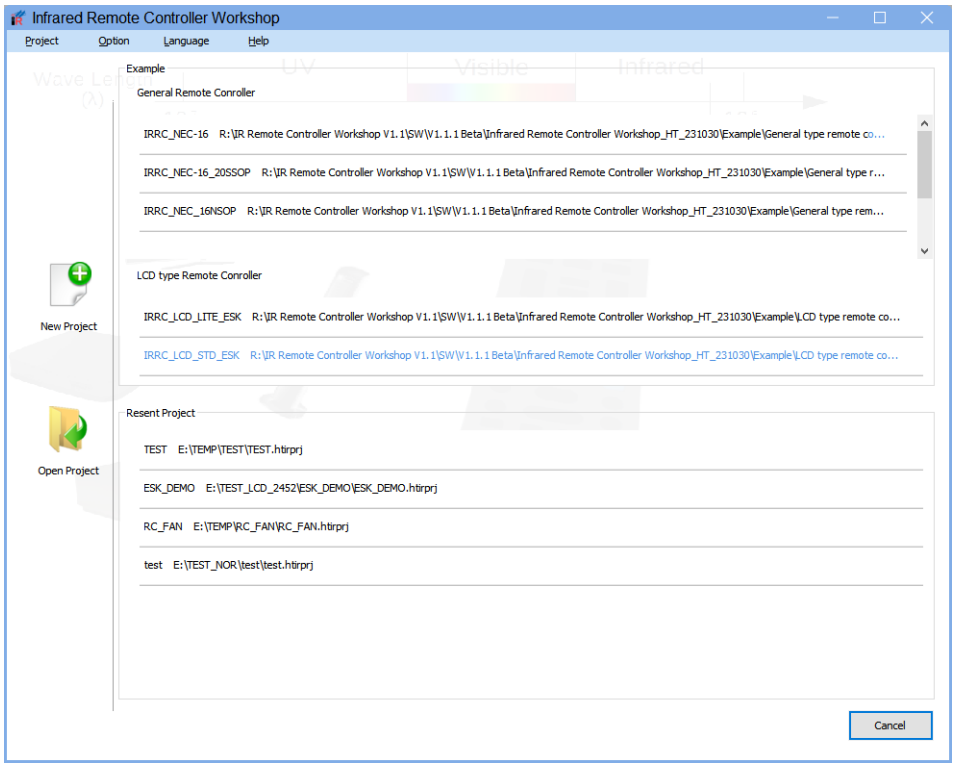
The menu bar at the top left will show the following menus from left to right: Project, Option, Language and Help.

The Project menu provides New Project and Open Project options.

The Option menu provides a decode widget, a battery life calculator windget and a reset functional configuration demonstration function.

The Language menu provides a choice of Simplified Chinese, Traditional Chinese and English.

The Help menu provides the user guide, development board schematic design, infrared remote controller knowledge base and workshop version information.



Project Management

In the Project Management screen, users can create a new project or open an old project. Several sample solutions are also provided on the software screen for users to refer to.

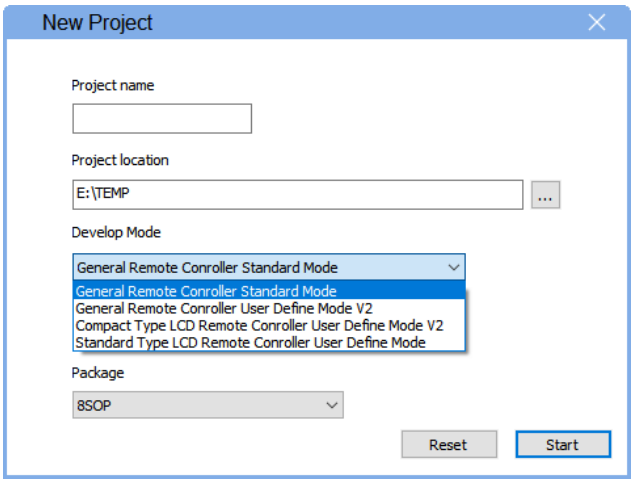
The remote controller development process in the workshop software consists of the following main configuration steps:

a) Protocol definition

b) LCD display content – for LCD remote controllers only

c) Key and driver configurations

d) Generate a project which can be used for secondary development, go to the HT-IDE3000 and then compile it to generate the programming files

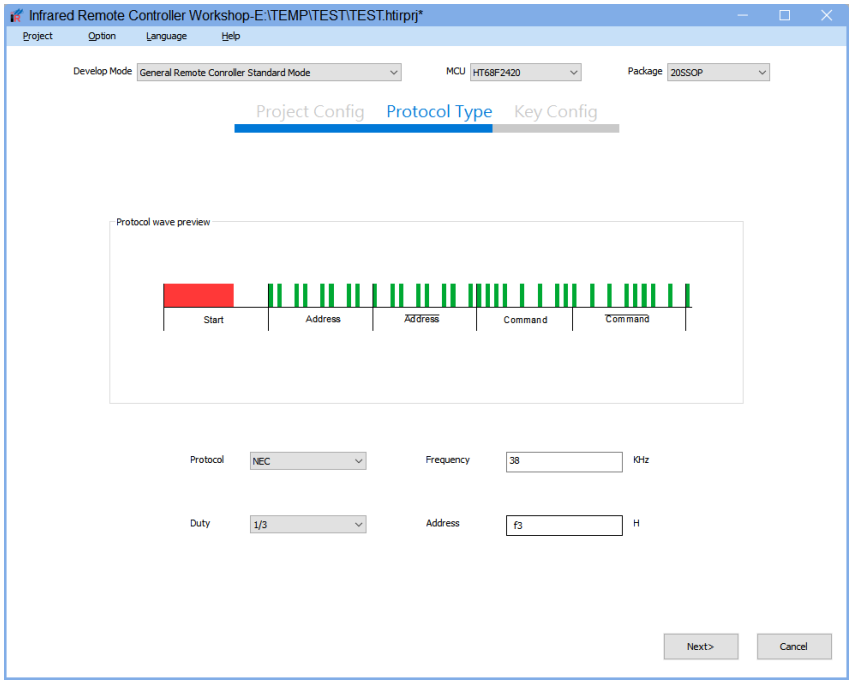


Project Creation

2.1 General Remote Controller Development

The general remote controller development supports two development modes: standard protocol mode and user defined protocol mode.

2.1.1 Standard Protocol Mode Development



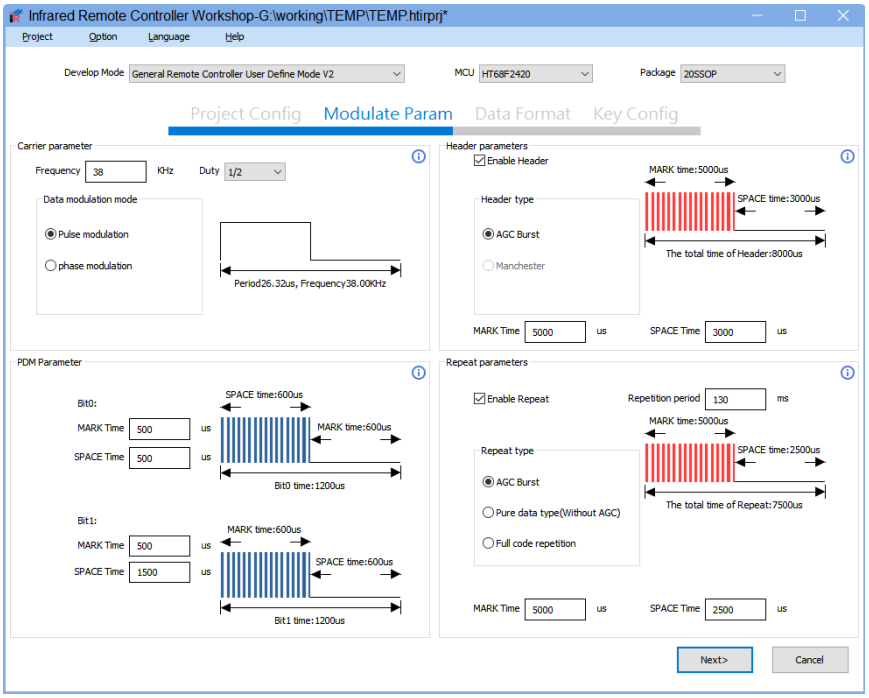
Standard Protocol Mode Configuration

As shown above, the general remote controller standard protocol development is divided into two steps. In the protocol selection step, NEC, NEC-16, Philips RC-5, Philips RC-6, and other popular standard protocols on the market can be selected. When using a standard protocol, it is not required to configure any protocol controlled parameters. In addition, the software view provides a waveform preview function. After the standard protocol which is to be used is selected, it is only necessary to configure the appropriate duty and address code to complete the configuration of the protocol part.

2.1.2 User Defined Protocol Mode Development

The general remote controller user defined protocol mode development is divided into three steps. The first step is to set the modulation parameters, the second step is to configure the data format, and the third step is to configure keys.

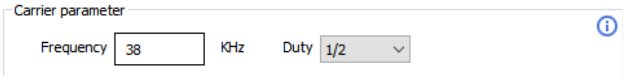
On the Modulation Parameters page, the carrier parameters, Bit1 and Bit0 modulation parameters, header parameters and repeat code parameters can be defined by users.



User Defined Protocol Mode Configuration

The specific configuration operations are as follows:

Carrier

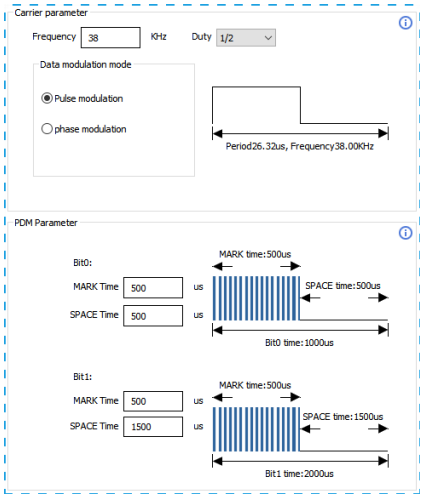


Carrier Parameters

As shown above, in the user defined protocol mode, the carrier parameters can be defined by users. The carrier frequency ranges from 30kHz to 58kHz and the duty can select 1/2, 1/3 or 1/4.

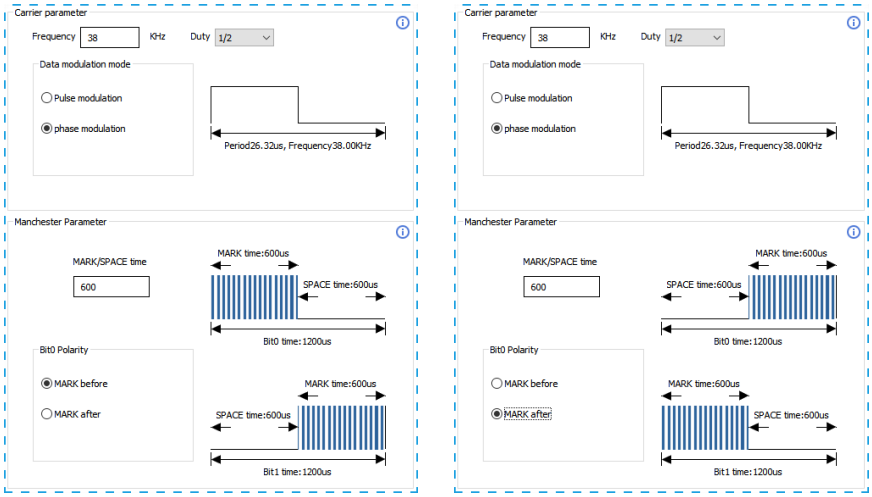
Data Modulation Mode

The data modulation mode can select either pulse modulation (PDM) or phase modulation (Manchester).



Pulse Duration Modulation (PDM) Parameters

The figure above is a configuration diagram showing the pulse duration modulation parameters of Bit0 and Bit1. In the software, the MARK (Continuous Carrier Pulse) time and SPACE (No Pulse) time for Bit0 and Bit1 in the modulation signal sent by the remote controller can be configured. The MARK, SPACE and total time parameters are displayed graphically on the right side by the software.



Phase Modulation (Manchester) Parameters

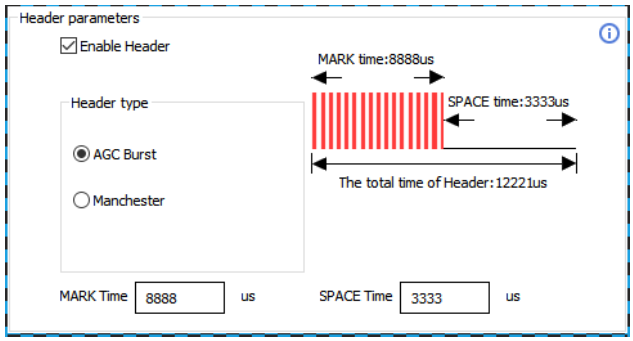
The figure above is a configuration diagram showing the phase modulation parameters. In the software, the MARK/SPACE time of Bit0 and Bit1 can be configured. For the phase modulation, only one time parameter needs to be set. Then use the Bit0 polarity definition to select whether the MARK time of Bit0 is in front or behind. The MARK, SPACE and total time parameters are displayed graphically on the right side by the software.

The MARK and SPACE parameters can be configured within a range of 300μs~2000μs.

Header Parameters

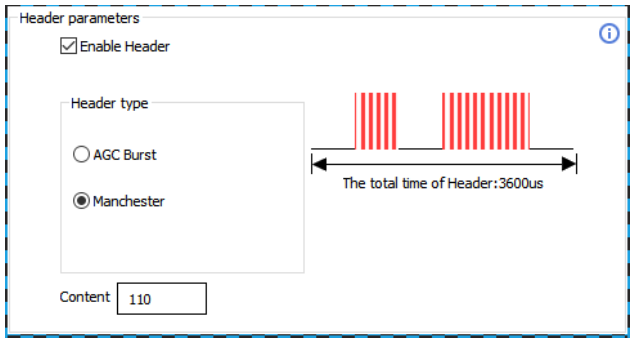
The Header is used by the remote controller to send an initialisation and calibration signal before sending the control signals to a receiver.

The header supports both AGC Burst and Manchester types. The Manchester (phase modulation) type header is only available when the phase modulation is selected.



AGC Burst Type Header Parameters

As shown above, the AGC Burst type header consists of a period of MARK and SPACE that is longer than the universal data code. The AGC Burst type header assists the receiver to initialise the gain, but the MARK time is proportional to the power consumption. Therefore this parameter should be configured correctly. It is recommended to set this between 4ms and 20ms. The MARK, SPACE and total time parameters are displayed graphically by the software.



Manchester Type Header Parameters

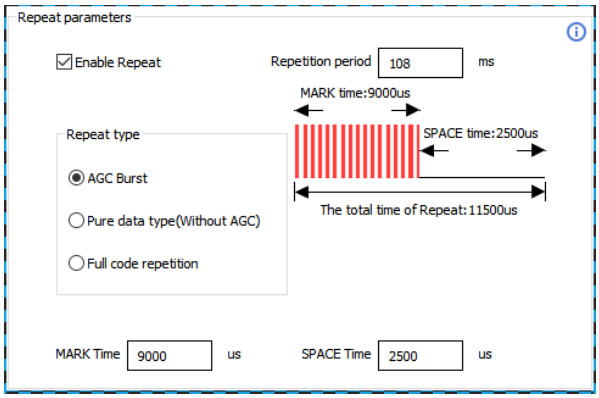
As shown above, when data is modulated using the Manchester mode, a digital header similar to the Philips RC-5 protocol can be used. The header in the software can be configured with up to 3 bits. The positions of MARK and SPACE as well as total time parameter are displayed graphically by the software.

Repeat Code Parameters

The Repeat Code is used for the remote controller to send a repeat signal when a button is held down.

As shown below, when the repeat code is enabled, the repeat code parameters can be configured.

The repeat code is categorised into AGC Burst, pure data repeat and full code repeat types.



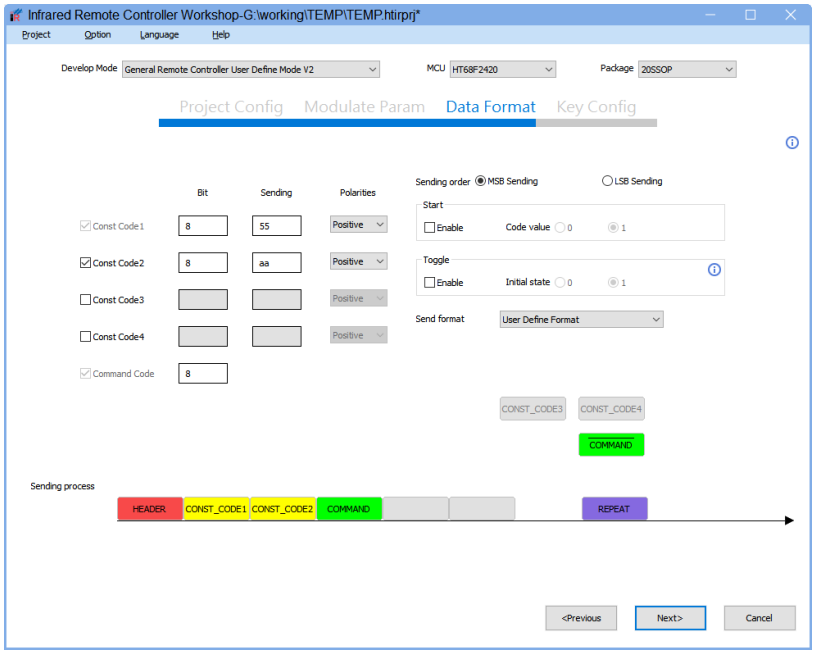
Repeat Code Parameters

Only the AGC Burst type repeat code needs to be configured, which can be inconsistent with the header. It is recommended to set this between 4ms and 20ms.

To ensure that the repeated second frame signal is sent 10ms later after the end of the first frame signal, the repetition period can be set between 40ms and 200ms.

Data Format

As shown below, on the Data Format page, the data format parameters can be set, such as constant code, command code, the sending order and whether to insert Start and Toggle bits or not.



Data Format Parameters

Constant code: 1~4 configurable groups, forced to be enabled in order by default. Each group can be configured to have a length of 1~8 bits and to be sent in orginal code (positive) or one's complement code (negative).

Command code: The number of bits is in a range from 1 to 8.

Sending order: Define how data is sent, either MSB or LSB first.

Start: A fixed bit is inserted between the header and data code.

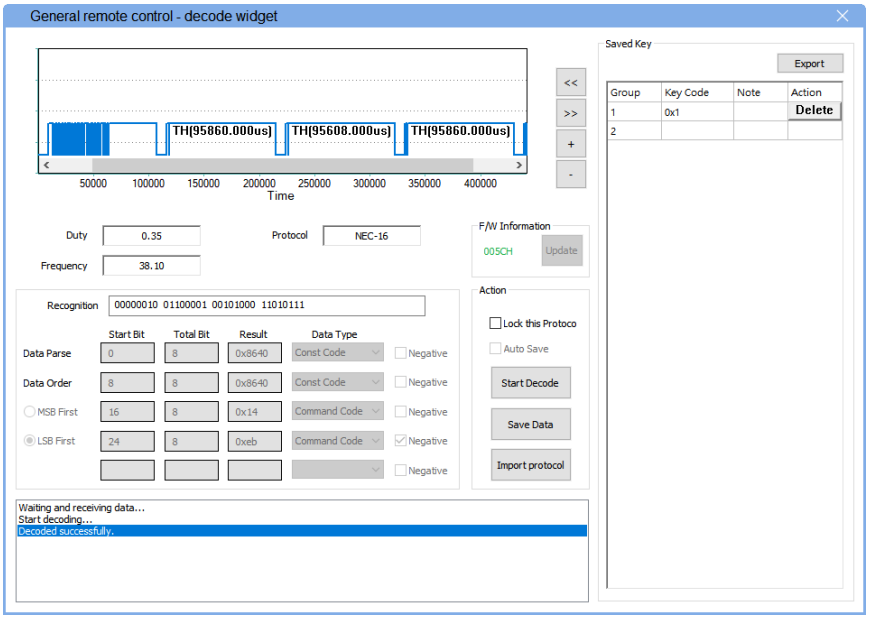
Toggle: A variable bit is inserted to distinguish whether the two codes sent by a remote controller in the full code repeat mode are repeated codes triggered by a long key press condition or two seperated codes triggered by two consecutive key presses.

Sending process: The sending process is shown with a timeline graph. The header is sent first, then the constant code, the complement of the constant code, the command code and the complement of the command code, which can all be chosen by dragging. The sending order can be adjusted arbitrarily.

2.1.3 Decode Widget

The general remote controller decode widget can be used to assist in the general remote controller development. The decoding function requires to connect the ESK-IRRC-R00 decoding board to the computer for use.

As shown below, the software will draw the sending code waveform using the output method of a general infrared receiver. The MARK with carrier is drawn with a low level and the SPACE without carrier is drawn with a high level. The contents below the waveform diagram are the decoded parameters of the sending code, such as the carrier duty, protocol type and frequency. The decoded 1/0 digits will be automatically filled into the Recognition field by the software. Below the recognition data are the decoded Address and Command. Only when a standard protocol has been identified will the software automatically identify the start bit and the total bit count of the address and command according to the protocol type. If the sending code does not conform to a standard protocol, the software will determine that it is a user defined protocol, which requires users to manually identify the constant code and command code.



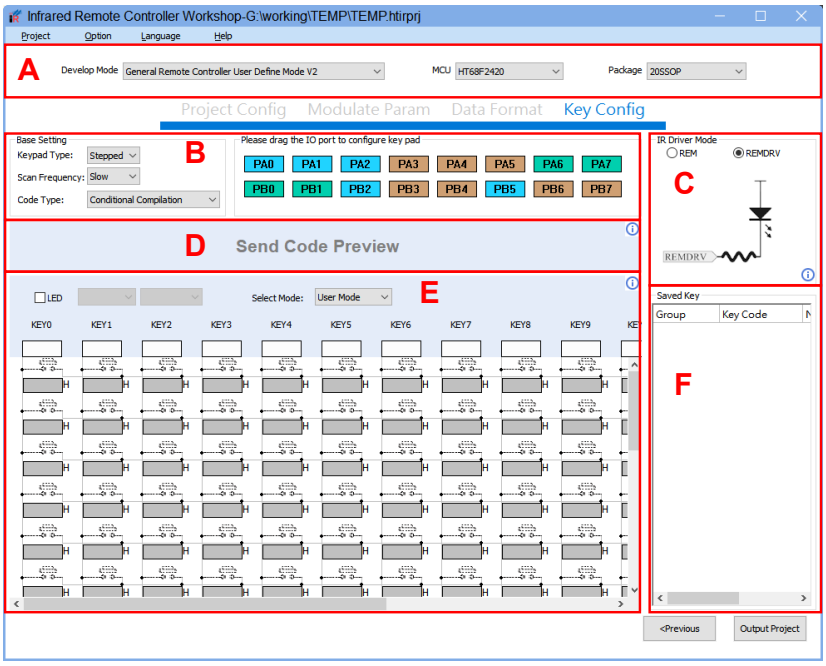
General Remote Controller Decode Widget

After identifying the protocol, the protocol can be locked and multiple keys on the remote controller can be decoded and saved. After saving all the necessary keys for development, pressing the Import Protocol can import the learned data into the remote controller solution under development.

2.1.4 Keys and Driver

The final step in developing a standard or user defined protocol for a general remote controller is key configuration. As shown in the following figure, area A is a solution type and MCU type configuration area, area B is a base setting and I/O selection area, area C is an IR LED driver mode selection area,

area D is a send code preview area, area E is a key I/O configuration and command code write area and area F is a saved key area for code development.

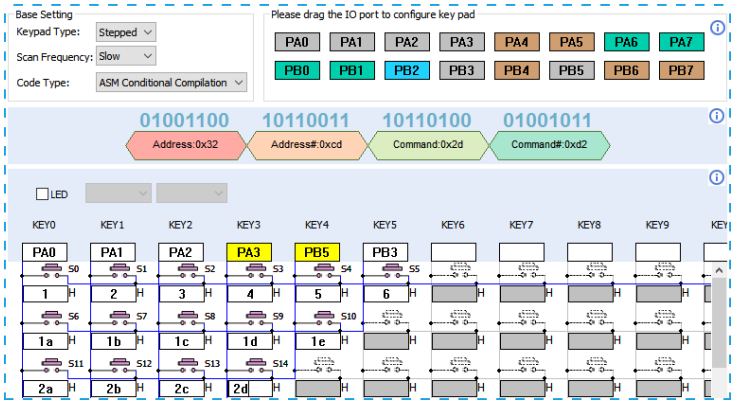


Key Configuration Page

2.1.4.1 Keys and I/Os

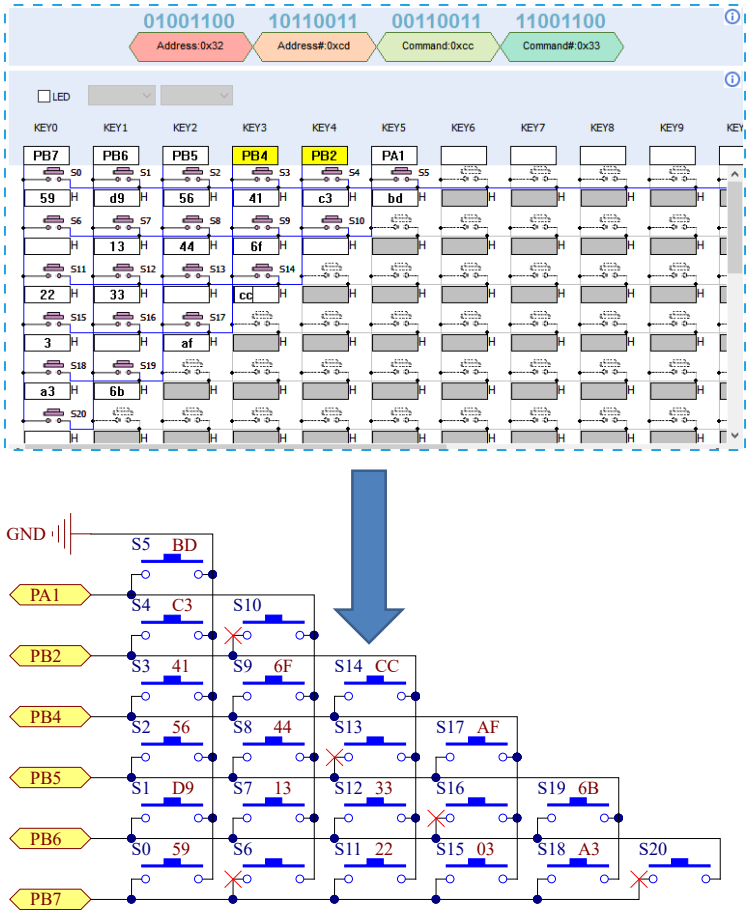
Area A, at the top left of the configuration page, can select the MCU package type. In area B, the base setting can select different keypad type and project output code mode, the blue pin icon in the I/O selection area is common to all package types of the device, the brown pin icon is unique to the 16NSOP and 20SSOP/20NSOP packages and the green pin icon is unique to the 20SSOP/20NSOP packages, the gray pin icon represents pins that have been used or are not included in the currently selected package. The I/O icon can be dragged into the key pin position of area E.

2.1.4.2 Stepped Keypad



Stepped Keypad Key Configuration Diagram

As shown above, when the stepped keypad type is selected and the I/O pins are configured to the Key configuration table, a stepped keypad is generated automatically. The maximum number of keys that can be generated is calculated using the formula: K=N×(N+1)/2, where N is the number of the configured I/O pins.



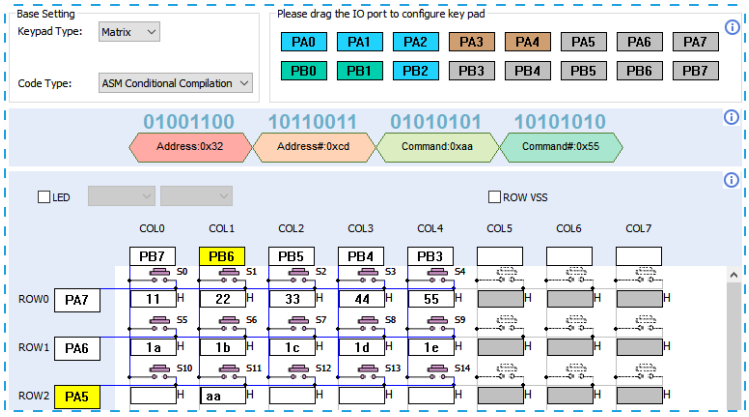
Relationship between Stepped Keypad Key Configuration and Schematic

After the I/O pins are configured to the stepped key area, the command code can be entered into the corresponding key code table. When clicking on any configurable key code, the two I/O pins corresponding to this command code will be highlighted in yellow. In the example shown above upper half, PB4 and PB2 are the two I/Os connected to key S14. After the command code is entered into the corresponding key code table, the send code preview area will prompt the sent code in binary. The binary code in the preview area is listed from left to right in chronological order. For the protocols that send code with LSB first, the binary code seen here is in reverse order.

When clicking on any command code on the first line, only one I/O will be highlighted in yellow. This is because the keys of this line are each implemented with an I/O and the VSS.

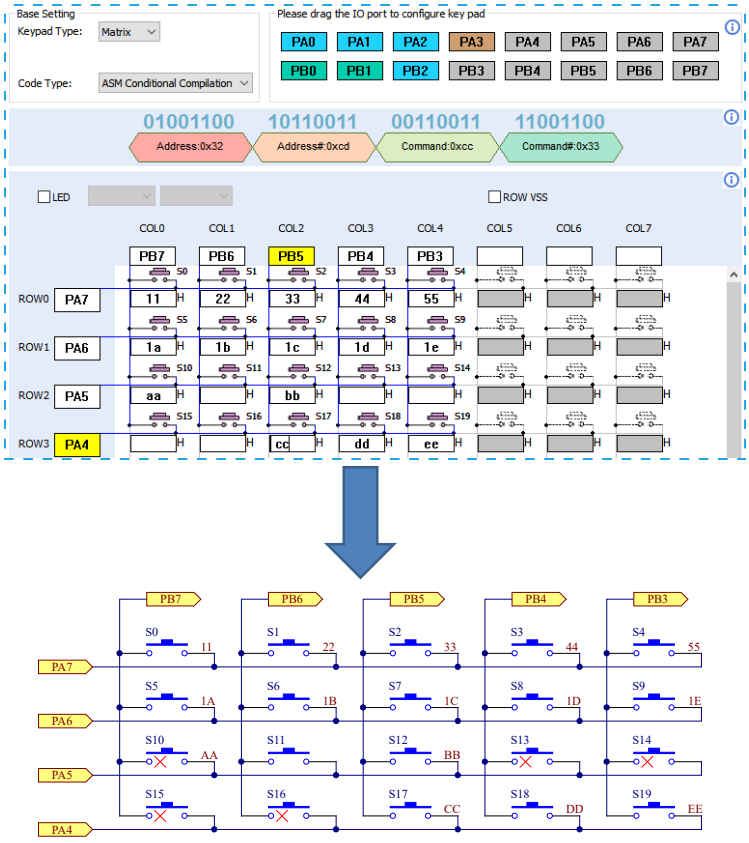
The figure above shows a stepped keypad table and its corresponding schematic diagram. Keys without configured key values are represented by crosses in the schematic diagram. S6, S10, S13, S16 and S20 in the figure will be included in the scanned code table during configuration generation, even if their key values are not configured or no keys are soldered at the corresponding positions in the physical circuit. The unconfigured keys are filled with 00H by default in the software-generated key value table.

2.1.4.3 Matrix Keypad



Matrix Keypad Key Configuration Diagram

As shown above, when the matrix keypad type is selected, after the I/O pins are configured to the ROWs and COLs of key configuration diagram, a matrix keypad will generate automatically. The maximum number of keys that can be generated is calculated using the formula: K=ROW×COL. For the 8-pin SOP package, 5 I/O pins can configure up to 6 keys. For the 16-pin NSOP package, 12 I/O pins can configure up to 36 keys. For the 20-pin NSOP/SSOP packages, 16 I/O pins can configure up to 64 keys. Enabling the ROW VSS option will add an additional set of keys equal to the number of COLs.



Relationship between Matrix Keypad Key Configuration and Schematic

After the I/O pins are configured to the matrix key area, the command code can be entered into the corresponding key code table. When clicking on any configurable key code, the two I/O pins

corresponding to this command code will be highlighted in yellow. In the example shown above upper half, PB5 and PA4 are the two I/Os connected to key S17. After the command code is entered into the corresponding key code table, the send code preview area will prompt the sent code in binary.

If the ROW VSS option is enabled, when clicking on any command code on the ROW VSS line, only one I/O will be highlighted in yellow. This is because the keys of this line are each implemented with an I/O and the VSS.

The figure above shows a matrix keypad table and its corresponding schematic diagram. Keys without configured key values are represented by crosses in the schematic diagram. Even if some key values are not configured or no keys are soldered at some positions in the physical circuit, they will be included in the scanned code table during configuration generation. The unconfigured keys are filled with 00H by default in the software-generated key value table.

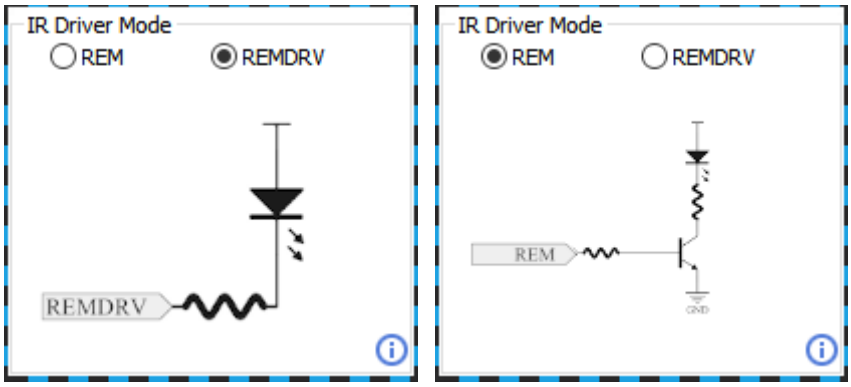
2.1.4.4 Develop Mode

When the HT68F2420 20-pin SSOP MCU package type is selected, the keypad configuration mode can be set to develop mode. The keypad compatible with the development board can be one-click configured, a stepped keypad can be configured with 136 keys, while a matrix keypad can be configured with 72 keys. Because the HT68F2420 ESK-IRRC-T00 development board is drawn in the form of a stepped keypad and printed with silk screen on the PCB. Therefore, the software identifies the matrix keypad key positions according to the silk-printed key positions corresponding to the I/O configuration on the ESK-IRRC-T00 development board, rather than the natural sequence.

2.1.4.5 LED Driver

The LED driver includes an MCU dedicated pin to drive an IR LED transmitter and an I/O to drive an LED indicator.

The IR LED driver mode is shown below.



IR LED Driver Configuration

The IR LED that transmits the infrared signal is driven by the remote controller via the MCU REM or REMDRV pin. The REMDRV driver mode can provide a larger drive current to directly drive the IR LED. Using the REM driver mode requires to combine with an external bipolar or MOSFET transistor to improve the output drive capability.

The I/O pin to drive an LED indicator can be a functionally indepedent pin which is selected in area E. In the stepped keypad, it can also be pin-shared with KEY0. If the LED indicator drive pin is pin-shared with a key pin, in order to reduce power consumption and prevent the indicator from being illuminated, the LED indicator must be configured at KEY0.



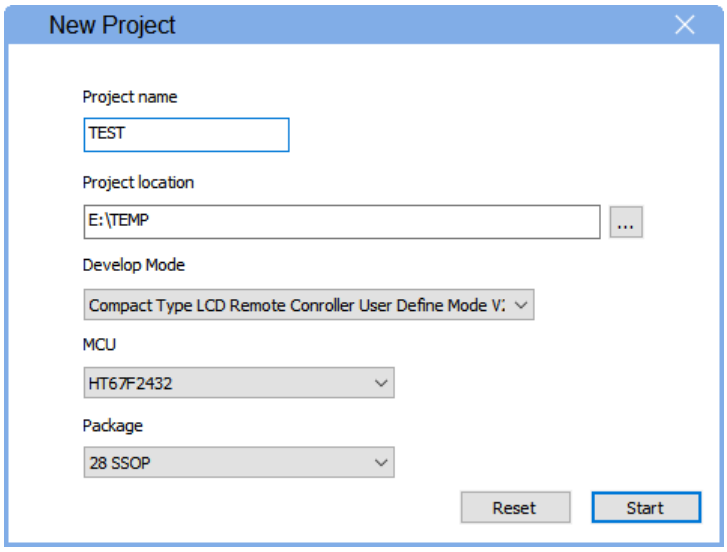
Indicator Configuration

After completing the configuration, users can choose the type for the generated code in the Base Setting in area B. Users can choose either the Conditional Compilation or Generative method to generate an IDE project. The Conditional Compilation is more convenient for secondary development and the Generative programs have better readability.

After completion, click Output Project to generate the project files of the development solution.

The automatic naming rule for the generated folder is "project name_year-month-day-hour-minute-second".

2.2 LCD Remote Controller Development



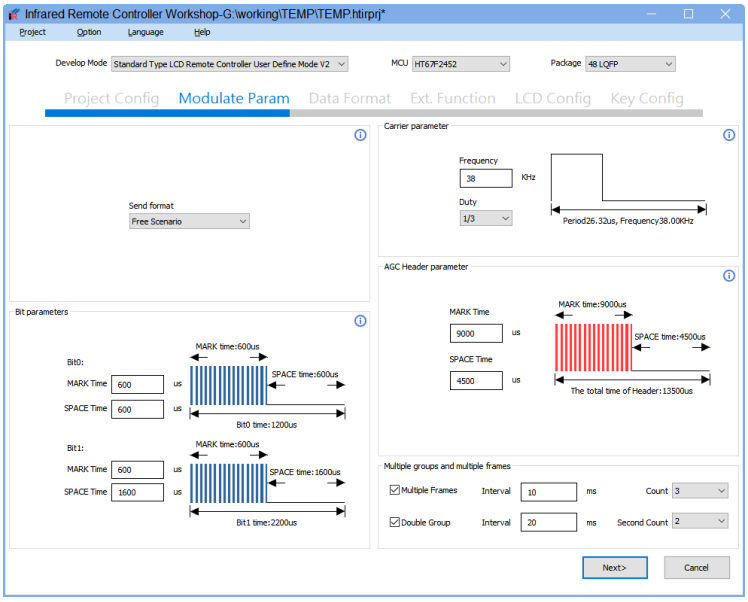
Project Setting for LCD Remote Controllers

According to the different resources of the Holtek LCD remote controller MCUs, the workshop provides two solutions, the Compact Type LCD Remote Controller and the Standard Type LCD Remote Controller. Both solutions have basic key detection, LCD display and infrared emission functions. The Standard Type LCD Remote Controller has more available resources compared to the Compact Type LCD Remote Controller, adding several optional configuration functions. The specific differences between the two solutions are shown below:

	Compact Type LCD Remote Controller	Standard Type LCD Remote Controller
Code Mode	Single-group Single/Multiple frames	Single-group Single/Multiple frames Double-group Single/Multiple frames
Timer Mode	2 options available	3 options available
Double Key Simultaneous Pressing	×	√
Switch Units	×	√
Lock Keypad	×	√
Clock Display	×	√
Applicable ROM	2K	4K and above

2.2.1 Modulation Mode

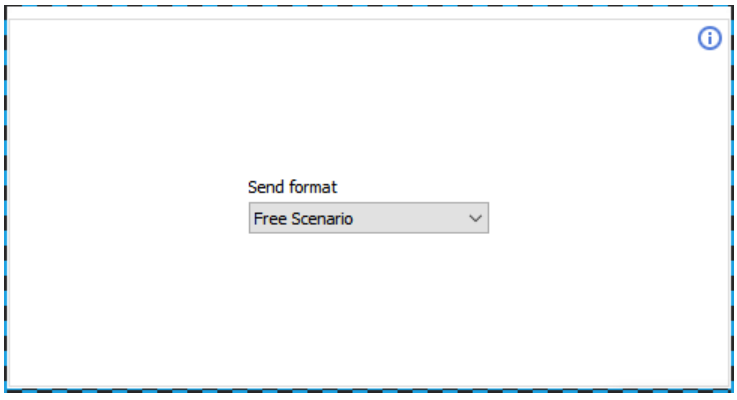
The workshop software provides a user defined protocol mode for LCD remote controller development. Users can define their own parameter and code rules according to their product requirements.



Modulation Mode Configuration Page

The first step for code configuration is to configure the modulation mode. The LCD remote controller code can only use the PDM modulation mode and does not support the phase modulation mode. The modulation mode page contains four parts, which are send format, carrier parameters, bit parameters, AGC header parameters, multiple groups and multiple frames. The second group code is only available for the Standard Type LCD Remote Controller.

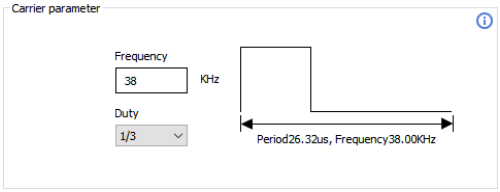
Send Format



Send Format

In the send format, the software provides two integrated design schemes which are configured with different modulation modes, modulation parameters and data formats.

Carrier Parameters

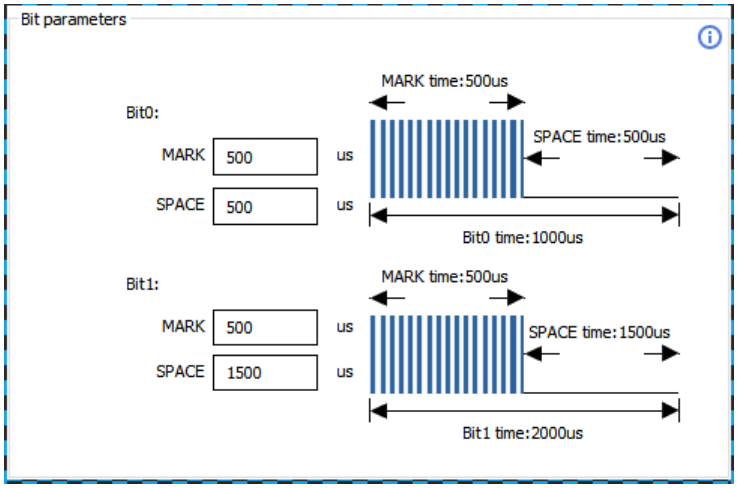


Carrier Parameters

The carrier parameters can be set by users, such as frequency and duty. The carrier frequency ranges from 30kHz to 58kHz and the duty can select 1/2, 1/3 or 1/4.

Bit Parameters

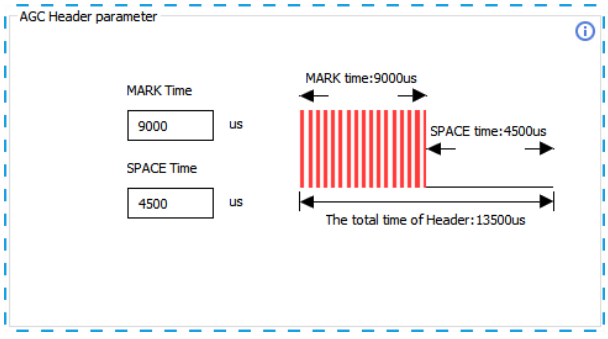
In the Bit Parameters area, the MARK (Continuous Carrier Pulse) and SPACE (No Pulse) time of Bit0 and Bit1 can be configured. The MARK and SPACE time parameters are displayed graphically by the software. The MARK and SPACE time can be set to between 300μs and 2000μs.



Bit Parameters

Header Parameters

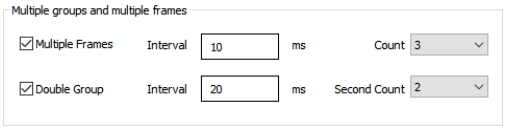
The Header is used by the remote controller to send an initial calibration signal to a receiver. The header for LCD remote controllers only supports the AGC Burst type. The AGC Burst type header consists of a period of MARK and SPACE that is longer than the universal data code. The longer MARK in the AGC Burst type header assists the receiver to initialise the gain. The software limits the header time between 3ms and 20ms. The MARK, SPACE and total time parameters are displayed graphically by the software.



Header Parameters

Multiple Groups and Multiple Frames

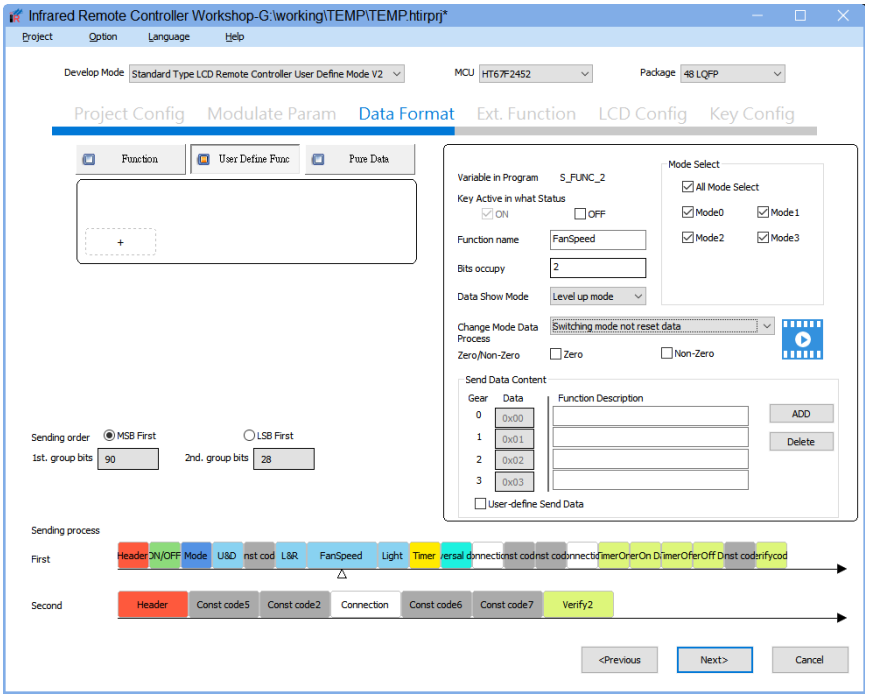
The LCD remote controller can send a long string of data in frames or groups. This facilitates decoding and prevents code errors when the remote controller's battery voltage is low and drops too quickly.



Multiple Groups and Multiple Frames

2.2.2 Data Format

The second step for code configuration is to configure the data format. The data format for the common LCD remote controllers is to modulate the LCD display content into the sending data.



Data Format Page

The data format page is mainly used to configure the Send Data.

The left side of the page is the configurable list for Send Data, the right side of the page is the configurable content for Send Data. The Sending order in the lower left side can be configured, either LSB or MSB first. The bottom side displays the sending process in a timeline graph. The Compact Type LCD Remote Controller provides one set of data transmission, while the Standard Type LCD Remote Controller provides two sets of transmission. The double-group mode application can be used to send data conditionally via secondary development. A typical application is for Gree's air conditioner remote controller, which sends two groups only when the timer function is enabled and sends one group when the timer function is disabled to reduce power consumption.

The list on the left side is divided into three types of data based on functional differences, namely general function data, user defined function data and pure data. To configure the data to be sent, simply select the corresponding data block and drag it to the sending process below.

The general function data includes ON/OFF, Mode and Timer, among which the ON/OFF and Mode are essential functions, and each function has a corresponding LCD display and a corresponding key.

The user defined data are sending functions defined by users according to their requirements. Each function has a corresponding LCD display and a corresponding key.

The pure data includes universal data, constant code, timer related data, verify code and free data. The universal data has corresponding LCD digital displays and are controlled by the "+" and "-" keys, while other pure data does not have corresponding LCD displays or keys.

The right side of the page contains user configurable parameters.

Variable in program: the variable in the generated project corresponding to the currently configured data;

Key Active in what Status: select the LCD display status in which the currently configured key can respond to key actions, either ON, OFF or both states;

Function name: the default name of the current configuration, the user defined functions and free data can be changed to the corresponding names according to development requirements;

Bits Occupy: the number of bits occupied by the currently configured function in the sending process. The minimum number of occupied bits is configured according to the binary code of the number of levels by default (can be modified during secondary development);

Mode Select (user defined data function configuration): configure user defined functions to be available in specific mode keys;

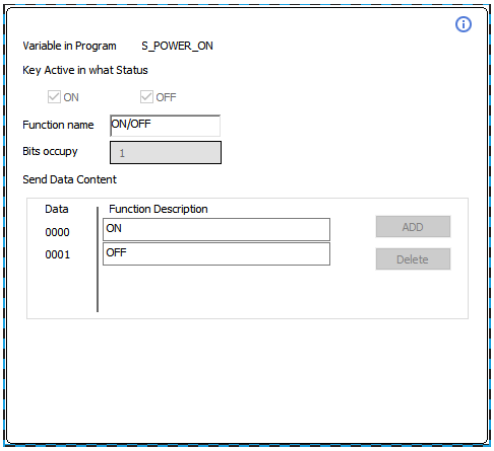
Data Show Mode (user defined data function configuration): Configure LCD display mode associated with the user defined function;

Change Mode Data Process (user defined data function configuration): configure the data processing mode for the current user defined function when pressing the "Mode" key of the remote controller to switch modes;

Zero/Non-Zero Display (user define data function configuration): whether to process the display content for this function in level 0 and non level 0.

Send Data Content: configure the number of levels for the user defined function and the function description of each level. This area allows to customize the sending data for each level.

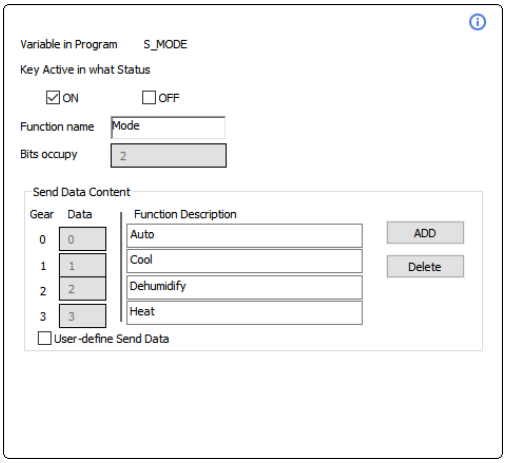
On/Off



On/Off Key Configuration

The on/off function should be configured to execute key actions in both the power-on and power-off states. The default definition for the generated program is 1 for on and 0 for off.

Mode



Shift Type Mode Key Configuration

The mode function is generally configured to execute key actions in the power-on state. In the sending data content design, the operating modes can be configured using the Add and Delete buttons, with up to 8 modes are allowed. The functional description can be written for each mode in the software. The mode function is displayed in a shift way on the remote controller LCD.

The sending content is the mode serial number by default, which can be defined as any data by the user.

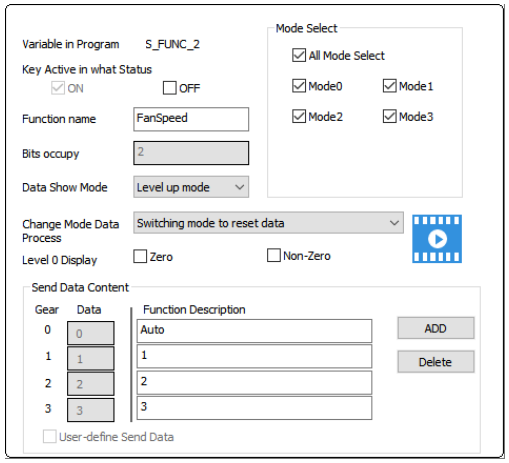
Timer



Timer Key Configuration

The timer function is generally configured to execute key actions in both the power-on and power-off states. By default, when the remote controller is in the power-on state, the timer key enables a timed power-off. When the remote controller is in the power-off state, the timer key enables a timed power-on. When the timer function has been enabled, if the on/off key is pressed, the remote controller will exit the timer mode. The minimum operation time for 24.5 mode is half an hour, for 24 mode it is 1 hour, and for 88:88 mode it is 1 minute. The data of the timer function is used to store the number of hours or half hours. It is recommended to set the data length to 6~8 bits.

User Defined Functions



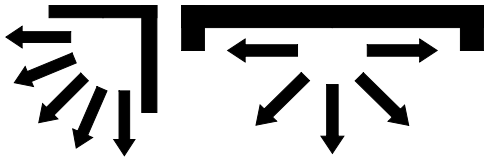
User Defined Functions Configuration

The user defined functions can be configured according to the user required key function characteristics.

The function name can be modified and will be accordingly shown on the LCD configuration and key configuration pages.

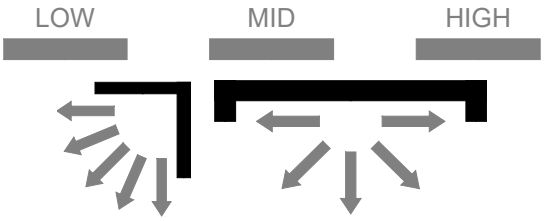
According to the remote controller LCD display mode, data can be divided into the following types:

(1) ON/OFF mode: Data displayed in the ON/OFF mode, such as the sweep up and down, sweep left and right, of the air conditioner remote controller, and the swing function of the fan remote controller. The data definition is 1 for on and 0 for off. As shown in the black icon below.



Common ON/OFF Mode Display Examples

(2) Shift mode: Data displayed in the Shift mode, such as the specified wind direction for the sweep function of the air conditioner remote controller, and the high, medium and low fan speed of the fan remote controller; direct wind, natural wind and sleep wind. As shown in the gray icon below.



Common Shift Mode Display Examples

(3) Bit mode: Using the carry mode to display data that requires simple addition, which can be used for water storage control of the water heater remote controller or sterilisation time type display control. As shown in the gray icon below.



Common Bit Mode Display Examples

(4) Level up mode: The display mode adds one block for each level up. Generally used for the air conditioner remote controller fan speed level control or water heater water level control. As shown in the gray icon below.



Common Level Up Mode Display Examples

(5) Digital mode: Display the function level in digits.

There are three methods for Change Mode Data Process: Share data, Switching mode not reset data, and Switching mode to reset data.

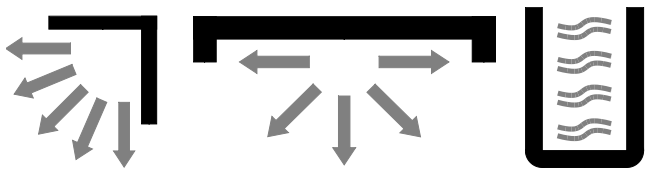
When the mode key is pressed to perform the mode changing operation, the differences in the use of the three data processing methods are as follows:

(1) Share data: this will keep the function level or ON/OFF status unchanged. For example, the air conditioner remote controller will still maintain the ventilation function after the mode is changed.

(2) Switching mode data not reset data: this will allocate an independent cache for each mode of this function. Switching mode will automatically load the previous level of the mode. For example, the air conditioner remote controller fan speed function cooling mode is set to level 3. After switching to other modes and changing levels, it can still maintain at level 3 when switching back to cooling mode.

(3) Switching mode to reset data: this will reset the function level to zero. For example, when the air conditioner remote controller is in the super cooling function status, it will ensure that the super cooling function is immediately turned off when the air conditioner is switched from cooling mode to non-cooling mode.

Level 0 is not displayed on the LCD by default. Some devices require a special display for level 0 (such as “AUTO”), and the Zero display can be enabled in the user defined function configuration. Some devices require a display of working in non level 0 status (such as the black icon below), then the Non-Zero display can be enabled in this user defined function configuration.



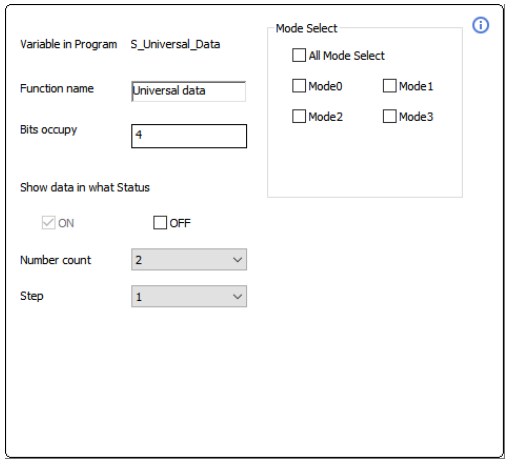
Common Non-Zero Display Examples

The Send Data Content area allows to increase or decrease the levels of the current design function. The maximum number of levels for the ON/OFF mode data is 1 level, for Shift mode is 7 levels, for Bit mode is 15 levels, for Level up mode is 7 levels and for Digital mode is 9 levels.

The sending content is the level serial number by default, which can be defined as any data by the user.

Pure Data

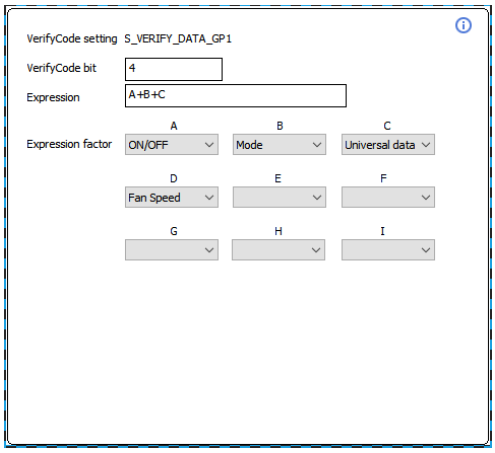
- **Universal Data**



Universal Data Configuration

The universal data is the data used by the LCD remote controller for global digital display. The common applications include the air conditioner remote controller temperature, stepless fan remote controller speed level, water heater/bathroom ceiling heater and ventilator remote controller temperature and the lighting product light intensity rang. The changes in universal data are controlled by the "+" and "-" keys on the remote controller.

- **Verify Code, Verify2**

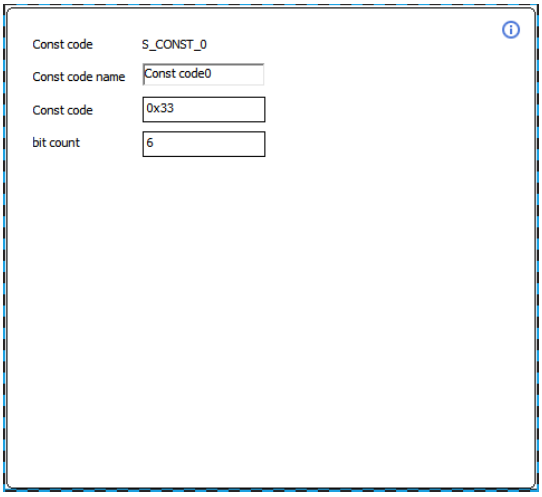


Verify Code Configuration

The verify code in the code is used for verification. To configure a verify code, users can select the configured sending data as an expression factor, and then add it to the formula in the expression bar to calculate the verify code. Expressions can use addition, subtraction, multiplication and division for this calculation. The verify2 is used to perform the verification calculation of the second group

code when the second group code is enabled. The verify codes can be set to have a 1 to 8 bit length. The compact type LCD remote controller has less ROM and RAM resources, it is not recommended to perform multiplication, division or other complex operations for the verify code.

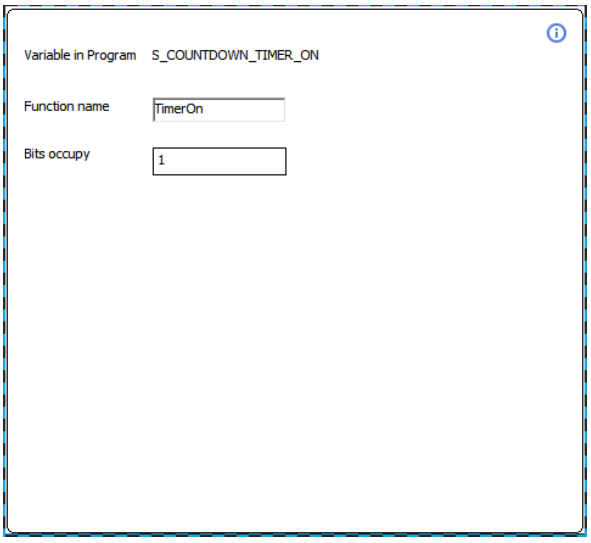
- **Constant Code**



Constant Code Configuration

The constant code is used for verification which has a pure data content and can be configured up to 10 sets. To configure the constant code, it is only necessary to fill in the constant code content and bit count. The constant code can be set to have a length of 1~8 bits.

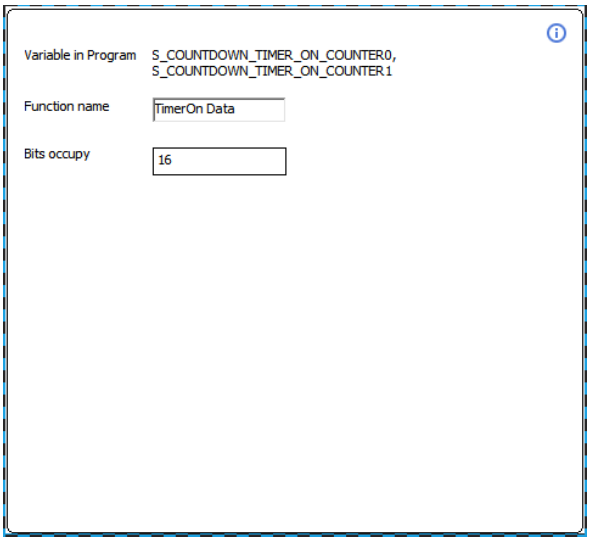
- **Timer On, Timer Off**



Timer On/Off Associated Data Configuration

The timer on and timer off in the code are used as confirmation bits for the timed power-on and timed power-off operations, which have a pure data content. If these data functions are enabled, the remote controller program will determine whether the timer on and timer off functions have been enabled. If so, the corresponding send bit will be set to 1. The timer on and timer off can be set to have a length of 1~8 bits.

- **Timer On Counter, Timer Off Counter**



Timer On/Off Counter Configuration

The timer on counter and timer off counter in the code are used to send the remaining time to the device, which have a pure data content. The timer on counter and timer off counter functions correspond to two 16-bit variables. When the timer function display mode is set to 24.5 or 24 mode, the timer on counter and timer off counter registers store the total remaining minutes, and it is recommended to set the data length to 11~16 bits. When the timer function display mode is set to Mode 3, the default lower 8 bits are for minutes, the higher 8 bits are hours, and the data length is fixed at 16 bits.

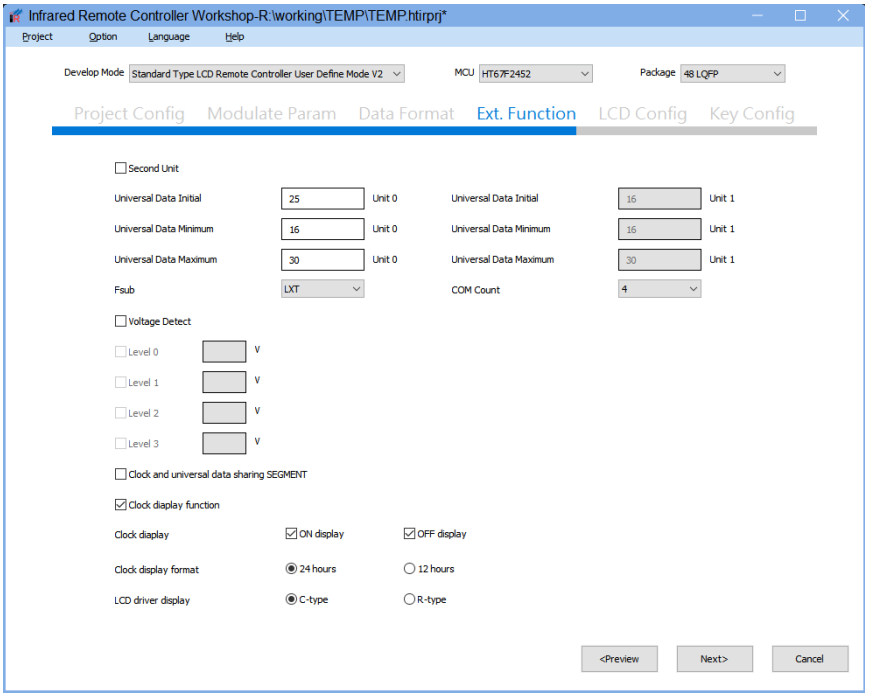
If the user has set a timer on or off counter using the remote controller and then uses the remote controller to send other functions (such as Level up or Shift modes) within half an hour or one hour, if this newly sent remote control data remains unchanged, the counter will be refreshed. Therefore, adding the timer on/off counter data to the sent data, which means to send the remaining minute data calculated by the remote controller MCU, can ensure that the timer on/off counter of the previously timed device remains unchanged.

- **Free Data**

The free data is a set of variable data in the sending process. For example, after either the sweep up and down or the sweep left and right function of Gree's air conditioner remote controller has been enabled, one of the bits in the remote controller's sending process will be set to 1 for confirmation.

The free data of the workshop only generates one data variable in sending process, and the default status of the data is 0. The data transformation operation requires to be implemented by the user through secondary development after the program is produced. The free data can be set to a length of 1~8 bits.

2.2.3 Function Configuration



Send Data Configuration

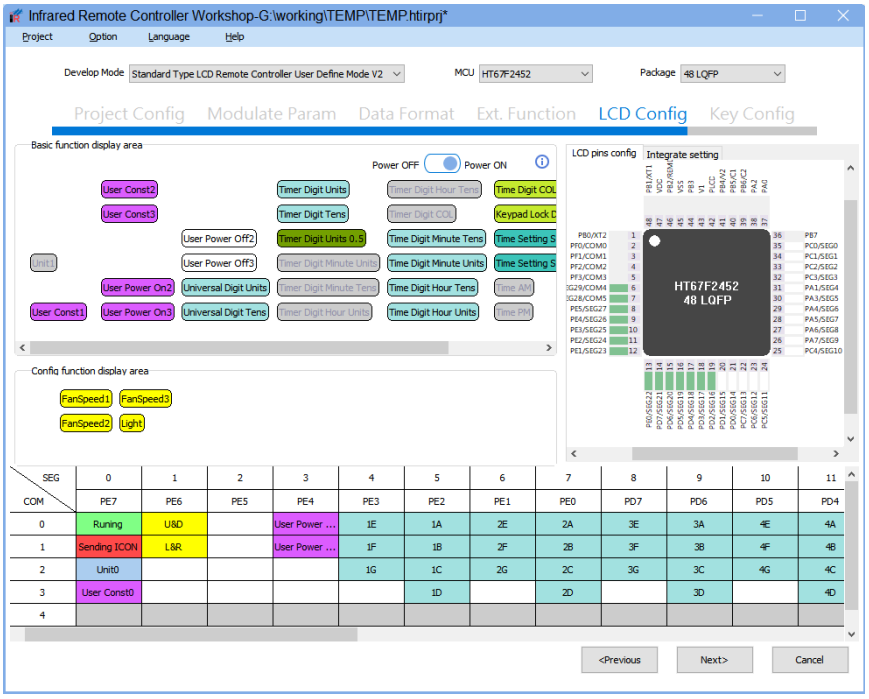
The universal data can display data ranging from 0 to 99, and its range can be limited in the functional configuration. For example, most air conditioners have a temperature range of 16°C to 30°C, while most water heaters have a temperature range of 30°C to 80°C. The Compact Type Remote Controller provides one unit of display data, while the Standard Type Remote Controller provides two units of display data.

The battery power detection is implemented by detecting the battery voltage, which can be configured with 2~4 levels. After enabling the Voltage Detect function, when the voltage is detected to be lower than the minimum level, the remote controller will not perform IR emission function.

The Clock display supports optional display of either 12 hours or 24 hours.

2.2.4 LCD Configuration

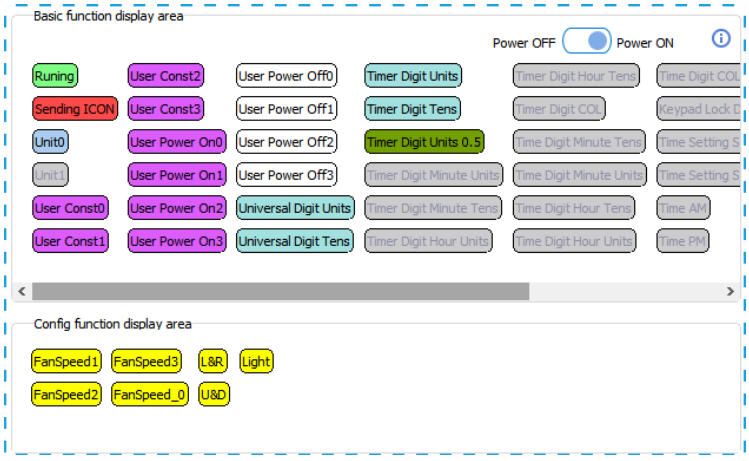
The workshop assists users in developing the LCD display function in the form of LCD RAM corresponding to LCD panel schematic and table. The compact type LCD remote controller supports 4-COM mode LCD drive, while the standard type LCD remote controller supports 3 to 6-COM mode LCD drive.



LCD Display Overall Configuration

The top left of the LCD configuration page is an LCD display cofiguration area, which is divided into two parts: the basic function configuration area and the user defined function configuration area.

LCD Display Configuration Area



LCD Display Configuration Area

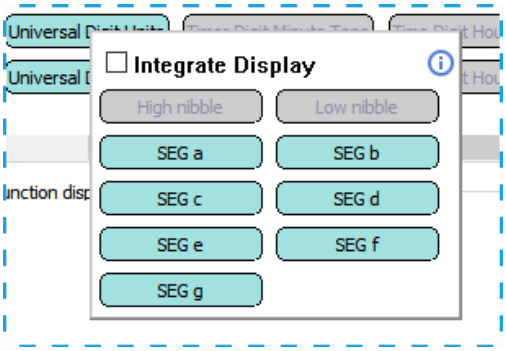
The display segments corresponding to the enabled functions are drawn in colour and can be dragged to the COM/SEG table configuration area below. The display segments corresponding to the disabled functions are drawn in gray and cannot be used. The user defined blocks will automatically

light up when Power ON is pressed, and will not light up when power off. If the user requires to make related display actions according to changes in other functions, the user can change the user defined display operation in the secondary development after the project is output.

The user defined function display area generates the relevant display blocks that can be dragged based on the user defined functions and the data format of each function.

Drag the enabled display block to the RAM Config function area below to enable the corresponding display function in the remote controller.

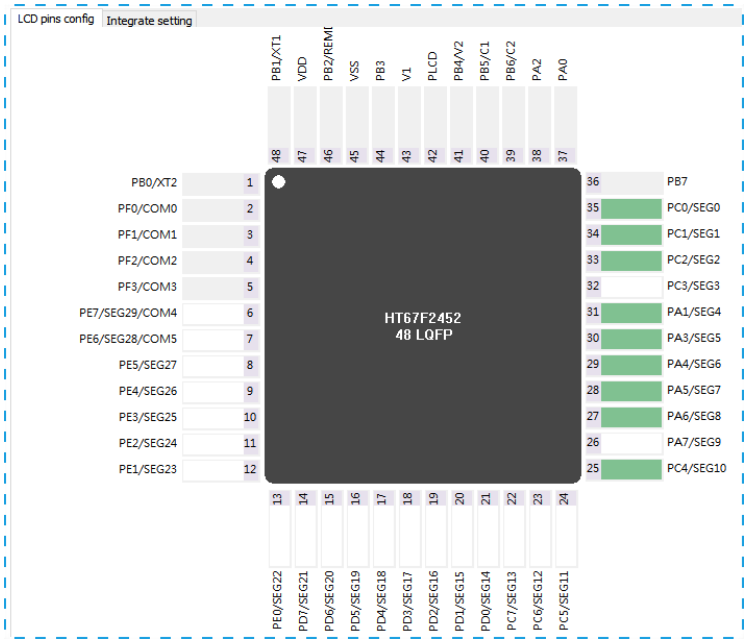
The LCD digit display supports both integrated and distributed display modes. The integrated display mode only supports 4-COM digits with all digits arranged in a consistent pattern; the distributed display mode supports 3 to 6-COM digits arranged in any pattern.



Digit Configuration

The switch of Power OFF and Power ON allows user to view the segments displayed in the power-on and power-off status.

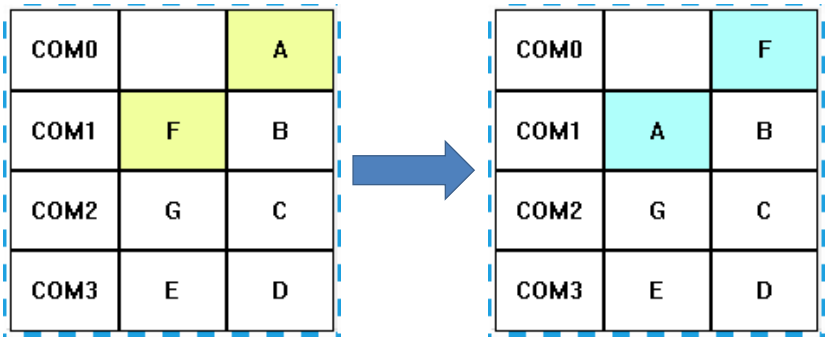
LCD Pins and Digit Adjustment Area



LCD Pins and Digit Adjustment Area

The right side is LCD pins and digit adjustment area. The SEG pins for the MCU to drive an driver LCD can be configured on the LCD pin configuration page. The SEG pins can be enabled by clicking on the white pin box, then the pin box will turn green after enabled.

The ingetrated digit setting page can configure the digit display. The software supports four COMs and two SEGs to form an A~G 7-segment digit, and can be compatible with different LCD screens by adjusting the segment arrangement in the digit adjustment area. The adjustment operation is shown in the following figure. Click “A” first, and then click “F” which needs to be exchanged, now the positions of “A” and “F” are exchanged. The other segments can also be exchanged to the corresponding driver positions in this way.



Exchange Method in LCD Digit Adjustment Area

RAM Mapping Area

SEG / COM	0	1	2	3	4	5	6	7	8	9	10	11
	PE7	PE6	PE5	PE4	PE3	PE2	PE1	PE0	PD7	PD6	PD5	PD4
0	Runing	U&D		User Power ...	1E	1A	2E	2A	3E	3A	4E	4A
1	Sending ICON	L&R		User Power ...	1F	1B	2F	2B	3F	3B	4F	4B
2	Unit0				1G	1C	2G	2C	3G	3C	4G	4C
3	User Const0					1D		2D		3D		4D
4												

LCD RAM Relational Table

The left column of the RAM mapping area contains COMs. The top row is for SEG pin configuration. The pins enabled as SEG function will be automatically configured from left to right to the SEG columns. The configured I/Os can be adjusted by dragging.

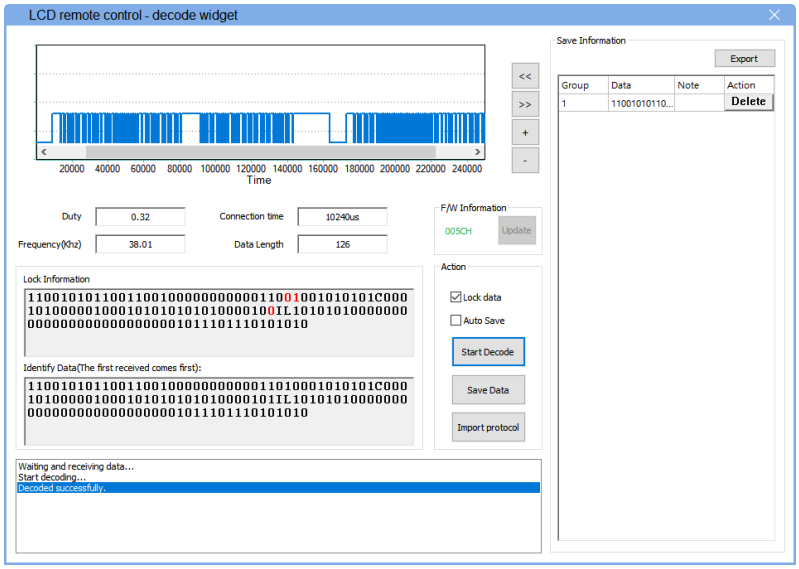
The digit display consists of 7 segments occupying 7 bits of space in the LCD RAM. The integrated digit drag-and-drop configuration operates by dragging half a byte at a time, while the distributed digit drag-and-drop configuration operates by dragging one bit at a time.

The integrated display mode supports to remove the F segment by right-clicking on the configured RAM mapping area, adapting to special glass that only displays digits 1-2. The distributed display mode can implement special drive methods corresponding to more customized segment control requirements.

2.2.5 Decode Widget

The LCD remote controller decode widget can be used to assist in the LCD remote controller development. The decoding function requires to connect the ESK-IRRC-R00 decoder board to the computer for use.

As shown below, the software will draw the sending code waveform using the output method of a typical infrared receiver. The MARK with carrier is drawn with a low level and the SPACE without carrier is drawn with a high level. The contents below the waveform diagram are the decoded parameters of the sending code, such as the carrier duty, protocol type and frequency. The decoder 1/0 digits will be automatically filled into the Recognition field by the software. Checking the "Lock data" option in the Action area can add the decoded data to the lock area. When decoding the next key, the recognised data will be automatically compared with the locked data. If there are differences between the new data and the locked data, the software will prompt the corresponding data in red to indicate changes.



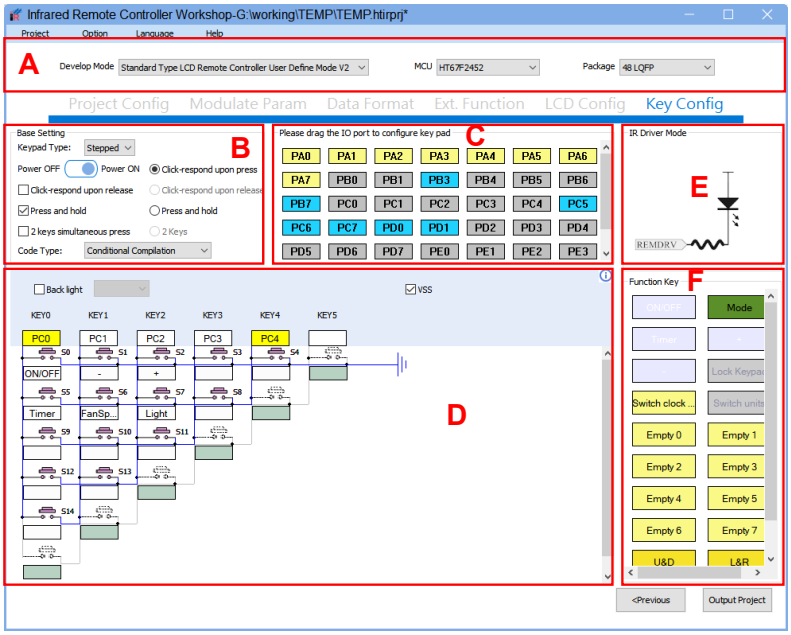
LCD Remote Controller Code Learning Mode

The LCD remote controller decode widget is only used to learn the LCD remote controller PDM mode code. By default, codes with longer SPACE are set to 1, while codes with shorter SPACE are recognized as 0.

The "Import protocol" function is used for code learning data record, which is convenient for users to record and compare parameters and does not involve data format or key configuration.

2.2.6 Keys and Driver

The final step in developing an LDC remote controller is key configuration. As shown in the following figure, area A is a solution type and MCU type configuration area, area B is an base setting area, area C is an I/O area for selection, area D is a key action configuration area, area E is an IR LED drive configuration area and area F is a function area for selection.



Key Configuration Area

2.2.6.1 Keys and Functions

Area A, at the top of the configuration page is MCU information area, can change the remote controller MCU package type. Area B is a base setting area, where users can select a stepped keypad or matrix keypad. There are four key response modes, which are click-response upon press, click-response upon release, press and hold, 2 keys simultaneous press. users can enable the desired key response modes based on the key response requirements, and configure the function keys to the corresponding response mode and power on/off status. Area C is an I/O area for selection, the gray blocks indicate the used or occupied I/Os. Area D is an I/O configuration area, the I/O icon in area C can be dragged into the I/O configuration position in area D. The back light function of area D is for the back light of the keypad or display screen, which will light up for 4s after pressing any key. After the I/O is configured to the keypad, select a control pin in area E. Drag the key function in area F into the key function block to enable the function.

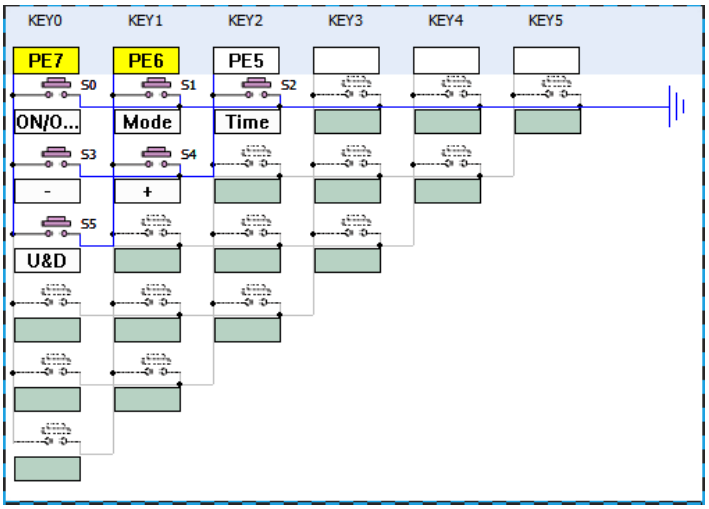
After enabling various key response modes according to the required functions, the user can configure the functions to the key table under the corresponding key response mode. Then click the Power ON / Power OFF switching button to configure the keys as power on response keys or power off response keys.

Please note the following:

- Some keys are active in both power on and power off states by default, such as Power ON, Timer, "+" and "-".
- By default, "click-response upon press" and "click-response upon release" cannot be configured to the same key to avoid the occurrence of two functions being executed simultaneously after the key is pressed.
- If the user needs to configure two different functions on the same key with one function responds to "press and hold", it is recommended to configure the other function to "Click-response upon release" mode. If "press and hold" and "click-response upon press" modes are configured to the same key, when the key is long pressed, the function corresponding to "click-response upon press" will also make a response action.

The code type of the output project can be either Generative or Conditional Compilation.

2.2.6.2 Stepped Keypad

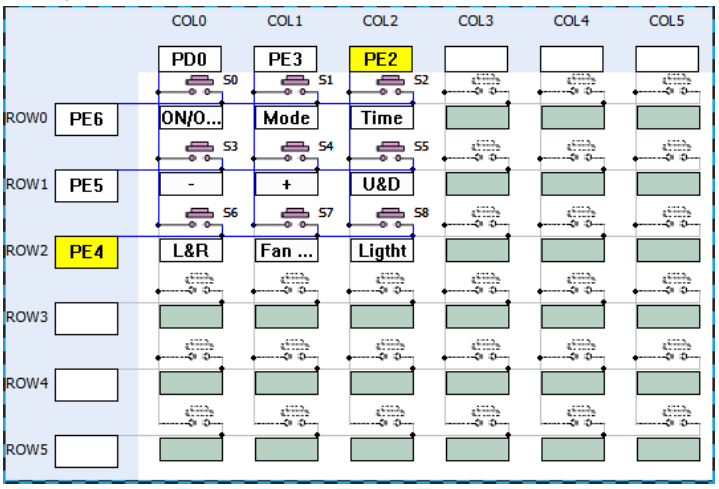


LCD Remote Controller Stepped Key

As shown above, when the stepped keypad type is selected and the I/O pins are configured to the Key configuration table, a stepped keypad is generated automatically. When VSS is checked to add

to the circuit, the keypad will have the maximum number of keys. The number of keys that can be generated is calculated using the formula: K=N×(N+1)/2. When VSS is not checked, the double key simultaneous pressing is supported. The number of keys that can be generated is calculated using the formula: K=N×(N-1)/2, where N is the number of the configured I/O pins.

2.2.6.3 Matrix Keypad



LCD Remote Controller Matrix Key

As shown above, when the matrix keypad type is selected, after the I/O pins are configured to the ROWs and COLs of key configuration diagram, a matrix keypad will generate automatically. The maximum number of keys that can be generated is calculated using the formula: K=ROW×COL.

2.2.6.4 IR Driver

The IR driver is configured according to the MCU function. If the MCU has built-in IR dedicated driver pins REM/REMDRV, the software will force to use the dedicated driver pins to drive the IR LED. If the MCU does not have IR dedicated driver pins, any PTM output pin can be selected to output the IR drive waveform in REM mode.

3. Workshop Hardware

The available components for the IR remote controller workshop supporting development board are as follows:

Development Board/ Development Board Module	Supported MCU	Function/Application	Supported Development Mode
*ESK-IRRC-T00	HT68F2420	136-key stepped integrated development board	General Remote Controller
*ESK-IRRC-T01	HT67F2432	15-key stepped integrated development board	Compact Type LCD Remote Controller
ESK-IRRC-R00	—	IR remote controller decoder board	All modes decode
BX-IRRC-TMT00	BX68R2420	Modular development motherboard with IR transmitter	General Remote Controller
ESK-IRRC-TM00	HT67F370	Modular development motherboard	Standard Type LCD Remote Controller
ESK-IRRC-TM01	HT69F340	Modular development motherboard	Standard Type LCD Remote Controller
ESK-IRRC-TM02	HT69F350	Modular development motherboard	Standard Type LCD Remote Controller
ESK-IRRC-TM03	HT69F360	Modular development motherboard	Standard Type LCD Remote Controller
ESK-IRRC-TM04	HT67F2452	Modular development motherboard	Standard Type LCD Remote Controller

Development Board/ Development Board Module	Supported MCU	Function/Application	Supported Development Mode
ESK-IRRC-TMK00	BS67F2432	Modular development motherboard with touch key	Compact Type LCD Remote Controller
ESK-IRRC-TDT00	—	Modular development board with display and IR transmitter	Compact Type LCD Remote Controller Standard Type LCD Remote Controller
ESK-IRRC-TK00	—	24-key matrix keypad modular development board	General Remote Controller Compact Type LCD Remote Controller Standard Type LCD Remote Controller
ESK-IRRC-TK01	—	136-key stepped keypad modular development board	General Remote Controller Compact Type LCD Remote Controller Standard Type LCD Remote Controller

Note: *The on board chip of the integrated development board uses a real MCU and does not support the emulation function.

3.1 Remote Controller Development Board

There are two development board types for IR remote controller workshop, namely integrated development board and modular development board. The integrated development board integrates MCU, IR transmitter, keys and display (only for the LCD remote controller development board) on one PCB. The modular development board divides the master controller, IR transmitter, keys and display (only for the LCD remote controller development board) functions into several different module boards, which can be assembled by users according to the functional requirements of the development project before development.

3.1.1 Integrated Development Board

The integrated development board ESK-IRRC-T00 is a general remote controller development board using the HT68F2420 as the master controller. It uses 16 I/O pins to form a 136-key stepped matrix keypad, which can emulate any I/O combination of keys.

The integrated development board ESK-IRRC-T01 is an LCD remote controller development board using the HT67F2432 as the master controller. It uses 5 I/O pins to form a 15-key stepped matrix keypad and 20 I/O pins to configure a 4×16 LCD driver.

The specific circuits can be opened through the Help menu.



Integrated Development Board

3.1.2 Modular Development Board

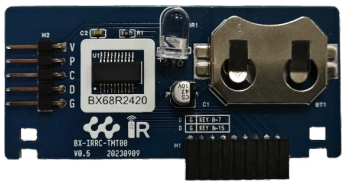
The modular development board can select different motherboards, combined with the functions of IR transmitter, display and keys required by the remote controller, a complete remote controller solution can be formed. The specific combined solutions are as follows:

Development Type	Motherboard	Development Combined Components 1	Development Combined Components 2
General Remote Controller	ESK-IRRC-TMT00	ESK-IRRC-TK00 ESK-IRRC-TK01	
Standard Type LCD Remote Controller	ESK-IRRC-TM00 ESK-IRRC-TM01 ESK-IRRC-TM02 ESK-IRRC-TM03 ESK-IRRC-TM04	ESK-IRRC-TK00 ESK-IRRC-TK01	ESK-IRRC-TDT00
Compact Type LCD Remote Controller	ESK-IRRC-TMK00	ESK-IRRC-TDT00	

Refer to the circuit diagram for the specific development board connector connection.

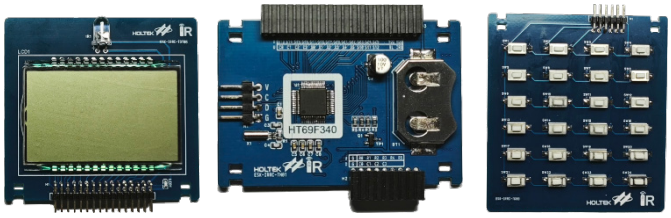
The modular development board divides the replaceable functions into three parts: display, master controller and keys according to the general remote controller applications.

The general remote controller does not include a display, and can be developed by combining the master controller board and keypad.



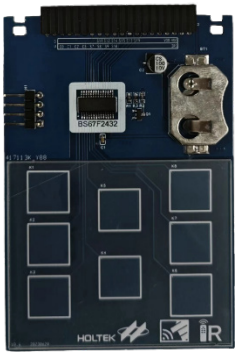
Modular General Remote Controller Development Board

The development for an LCD remote controller requires combining the display board, master controller board and keypad.



Modular LCD Remote Controller Development Board

The BS67F2432 is a touch remote controller MCU. To ensure better touch debugging, the development board ESK-IRRC-TMK00 integrates the touch keys with the master controller on the same board.



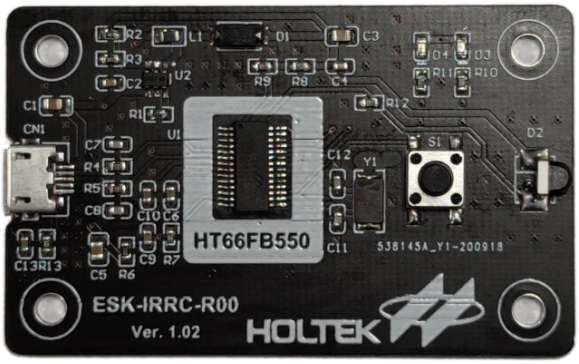
Modular LCD Remote Controller Development Board ESK-IRRC-TMK00

The integrated development board uses an MCU device without the emulation function, while the modular development board uses an EV chip. It should be noted that the EV chip cannot use the PA0 and PA2 I/O pins during emulation.

For the standard type LCD remote controller development board, the circuit uses C type driver by default. Changing the short-circuit jumper on the back of the development board can configure LCD screens with different voltages. Refer to the LCD section of the MCU datasheet for the specific relationship between the short-circuit connection and the C-type bias voltage.

3.2 Decoder Board

The ESK-IRRC-R00 is a decoder board which captures infrared carrier signals and uploads them to a computer via a USB interface on the board, then the decoded content is displayed on the workshop software. The decoder board is an HID device which does not require any additional drivers to be installed when being connected to a computer.

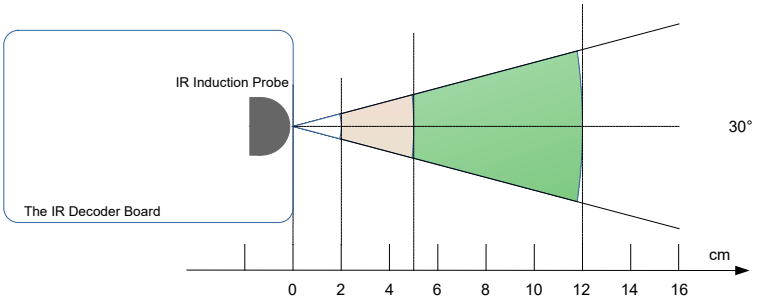


ESK-IRRC-R00 Decoder Board Hardware Diagram

After the decoder board is connected to a computer, both the red and green LEDs will turn on. When the computer has been identified the USB device successfully, the decoder board green LED will flash every 2 seconds.

After starting the decode widget from the software, press the decode key on the software or the key on the decoder board, the LED status of the decoder board will change to red light constant on, indicating the decoding starts.

The right side of the decoder board has the receiving induction probe which is used to sense infrared remote controller signals.

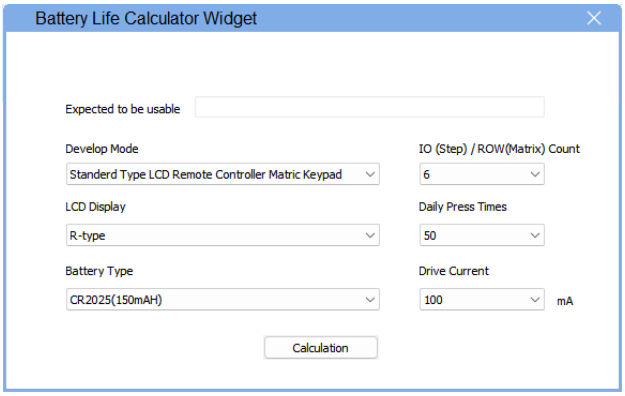


Receiving Top View

To ensure that the decoder board can operate in the best way possible, it is recommended that the angle from the remote controller transmitter to the decoder board induction probe should be no more than ±10 degrees up and down and no more than ±15 degrees left and right. In general, the optimal receiving distance should be between 5cm and 12cm (about 1 palm wide). For some remote controllers with lower power transmitters, the sending code distance can be reduced appropriately. A distance between 2cm and 4cm has the strongest code identification ability but this distance will make the identified carrier duty larger than it really is.

4. Description of Other Functions

4.1 Battery Life Calculator Widget



Battery Life Calculator Widget

The battery life calculator widget is used to estimate battery usage time when developing remote controllers. It can be opened from the Option menu. Developers can select the corresponding remote control configuration based on development requirements, select the battery type, then estimate users' daily remote control operation frequency to calculate the battery usage time of the generated project.

The calculation results are for reference only. The actual usage time may differ from the calculation results due to differences in the manufacturing processes of battery manufacturers.

4.2 F/W Power Control

The Infrared Remote Controller Workshop is especially designed for remote controllers. The power consumption for the remote controllers has been specially optimised.

Dynamic Power Control

On the market, some remote controllers have the IR LED completely on during the SPACE time, which is not good for battery life. The workshop generated remote controller program can implement a situation where the IR LED is only driven by the MARK duty time and is completely off during the SPACE control time, greatly extending the battery life.

General remote controllers normally need to send repeat codes due to their protocol. They will continue to send codes after their buttons are pressed. Most remote controllers do not set a time threshold. If any remote controller buttons are accidentally pressed by nearby objects, this will cause the remote controller to send repeat codes until the battery power is exhausted. However, this workshop's firmware can determine the number of repeat codes. When the remote controller enters a button pressed state, the repeat code will only be repeatedly sent 255 times. When this preset threshold is reached, the program will turn off the IR LED emission until the button is released to reduce power consumption.

Static Power Control

Using the F/W generated remote controller program, the general remote controller is woken up from the HALT mode by the WDT every 125ms to scan the keys. The LCD remote controller is woken up by a time base to detect the keypad approximately every 125ms, to change the timing/clock digit flashing action every 0.5s, to execute the backlight and clock timing every 1s, to calculate the timer every 4s and to detect the battery voltage every 16s.

4.3 Decode Recognition

The decoder board can identify code lengths of up to 148 combinations of MARK and SPACE which basically covers the codes of all general remote controllers and most LCD remote controllers.

As there are many remote controller protocols and code sending protocols on the market, some special protocols that do not conform to general coding rules may be difficult to identify in the workshop, therefore it is not guaranteed that every protocol can be recognised and restored. In the future, updated versions of the software will continue to enhance these learning functions and attempt to increase the range of available protocols.

5. Appendix & FAQ

5.1 LCD Remote Controller Functional Data, Keys, Display and Function Correlation Table

Function	Data variables	Associated Keys	Associated Display Variables	Function Definition
Power on/off	b_Power_ON S_POWER_ON	ON/OFF	DIS_POWER	FUNC_POWER_ SWITCH
Mode	S_MODE	Mode	DIS_MODE_x(x = 0~7)	FUNC_MODE_SWITCH
Universal Data	B_Universal_Data S_Universal_Data	+ / -	NUMBER_UNIVERSAL_ DATA_(a)_RAM(b) (a = 0, 1; b = 0, 1)	FUNC_KEY_INC, FUNC_KEY_DEC, FUNC_MODE_SWITCH, FUNC_UNIT_SHIFT_ SWITCH
Timer (mode 1,2)	REG_Countdown_Timer COUNTDOWN_TIMER_ SHOWONESTEP S_COUNTDOWN_TIMER S_COUNTDOWN_TIMER_ OFF S_COUNTDOWN_TIMER_ ON S_COUNTDOWN_TIMER_ ON_COUNTER(a) S_COUNTDOWN_TIMER_ OFF_COUNTER(a) (a = 0, 1)	Timer /ON/ OFF / + / -	DIS_COUNTDOWN_TIMER_ PWRON DIS_COUNTDOWN_TIMER_ PWROFF NUMBER_TIMER_(a)_ RAM(b) (a = 0, 1; b = 0, 1) DIS_TIMER_HALFHOUR	FUNC_COUNTDOWN_ TIMER_SWITCH FUNC_KEY_INC FUNC_KEY_DEC
Timer (Mode 3)	REG_Countdown_Timer_ MINUTE REG_Countdown_Timer_ HOUR S_COUNTDOWN_TIMER S_COUNTDOWN_TIMER_ OFF S_COUNTDOWN_TIMER_ ON S_COUNTDOWN_TIMER_ ON_COUNTER(a) S_COUNTDOWN_TIMER_ OFF_COUNTER(a) (a = 0, 1)	Timer / ON/ OFF / + / -	DIS_COUNTDOWN_TIMER_ PWRON DIS_COUNTDOWN_TIMER_ PWROFF NUMBER_TIMER_HOUR_ (a)_RAM(b) NUMBER_TIMER_MINUTE_ (a)_RAM(b) (a = 0, 1; b = 0, 1) DIS_TIMER_COL	FUNC_COUNTDOWN_ TIMER_SWITCH FUNC_KEY_INC FUNC_KEY_DEC
User Defined Function	ST_S_FUNC_x REG_S_FUNC_x S_FUNC_x (x = 0~19)	User Defined Function / Mode	DIS_MODE_S_FUNC_x DIS_FUNC_x_z DIS_FUNC_x_nz (x = 0~19)	FUNC_x_SWITCH (x = 0~19)

Function	Data variables	Associated Keys	Associated Display Variables	Function Definition
Set Clock	B_TIME_SET_STEP B_TIME_Hour B_TIME_Minute B_TIME_SET_TEMP_HOUR B_TIME_SET_TEMP_MINUTE	Setting / Switch / + / -	NUMBER_TIME_MINUTE_(a)_RAM(b) NUMBER_TIME_HOUR_(a)_RAM(b) (a = 0, 1; b = 0, 1) DIS_TIME_AM DIS_TIME_PM DIS_TIME_SETTING_STEP1 DIS_TIME_SETTING_STEP2	FUNC_TIME_SET_SWITCH ENTER_TIME_SET FUNC_KEY_INC FUNC_KEY_DEC
Clock	B_TIME_Hour B_TIME_Minute B_TIME_Second	None	NUMBER_TIME_MINUTE_(a)_RAM(b) NUMBER_TIME_HOUR_(a)_RAM(b) (a = 0, 1; b = 0, 1) DIS_TIME_AM DIS_TIME_PM DIS_TIME_COL	Time_Scond_plus
Key Lock	b_KEY_LOCK	Key Lock	DIS_LOCK	FUNC_LOCK_SWITCH
Unit	B_UNITSHOW B_Universal_Data	Unit	DIS_UNIT0 DIS_UNIT1	FUNC_UNIT_SHIFT_SWITCH

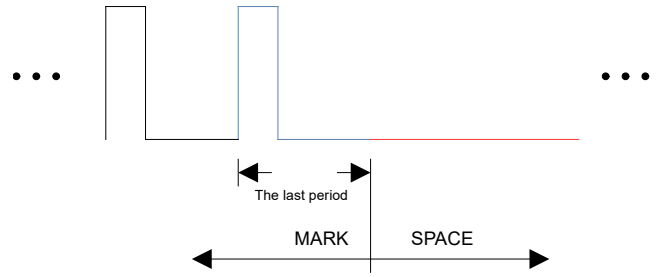
5.2 Special Modulation Code Description and Applications

In infrared remote controller modulation, some of the infrared code conforms to a specific protocol and can be decoded using the corresponding protocol specified decoder program. However, there are still some identification problems when the decoder board of the platform cannot predetermine the protocol which is used for decoding recognition. Specific cases are as follows.

Modulation Mode	Special Case	Decoding Exception Description	Solution
PDM	All bits are full 1 or full 0.	Because only one bit-length pattern is recognised after decoding, the decoding function configures it as 1 by default.	Avoid using the code wiht full 1 or full 0 for the address and keys.
PDM NEC-16	The address is configured as 55AAH or 00FFH.	Because the higher 8 bits and the lower 8 bits of 55AAH or 00FFH are the complement of each other and conform to the address encoding mode of the NEC protocol, the decoding identifies it as an NEC code in priority.	When using the NEC-16 protocol, the address code should avoid situations where the higher 8 bits and lower 8 bits are the complement of each other.
Manchester	All bits are full 1 or full 0.	Because only one bit-length pattern is recognised after decoding, the decoding function configures it as 1 by default.	The address and key should avoid using the code with full 1 or full 0; Add a toggle.
Manchester	The start bit is MARK sent last and the end bit is SPACE sent first. When sending code, all bits are full 10 or full 01.	Because only one bit-length pattern is recognised after decoding, the decoding function configures it as 1 by default.	Add a toggle; The address and key should avoid being configured to 55H or AAH.
Manchester	The header of the user defined protocol which is modulated using the Manchester mode is not effectively recognised as a header when decoded.	Because the Manchester type header has the same code pattern as the start, toggle and data bits, it cannot distinguish them from each other during recognition.	This is one of the user defined protocol features and does not affect the decoding of programs dedicated to this protocol.
LCD Remote Controller	All functions are off and the codes are full 0.	This causes the decoder board to recognise only one bit-length when all functions are configured to be off and no constant codes are included or constant codes are full 0.	The protocol should configure multiple groups of non-continuous constant codes with non-zero.

5.3 MARK and SPACE Design Error Description

For the decoding of MARK and SPACE by the receiver device, there is an error time of up to period×(1-duty) in the remote controller sending code. This error occurs due to the fact that different protocols have different understandings and designs for the MARK time parameters.



Last Period Processing

For example, when the protocol is designed that the carrier frequency is 38kHz and the duty is 1/3, if the MARK time is set within the range of 560μs~579μs, only the beginning and end of the output pulse have 22 IR pulses displayed on the oscilloscope or logic analyser. In such a case, the same waveform is output with a different MARK definition time. Therefore, the measured value is usually less than the actual MARK waveform time.

The decoder board of the remote controller workshop identifies the MARK time of the last pulse as a complete carrier period, as shown above. Therefore, the identified MARK waveform parameters are larger than the designed ones. It is recommended to make appropriate adjustments to the imported MARK parameters after the codes have been learned.

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