STEP TECHNICA CO.,LTD.

STEP TECHNICA

Hi-speed Link System

Satellite IC

MKY37

User's Manual

Preface

This manual describes the MKY37, or a kind of satellite IC in the Hi-speed Link System.

Be sure to read *"Hi-speed Link System Introduction Guide"* before understanding this manual and the MKY37.

In this manual, the Hi-speed Link System is abbreviated as "HLS".

● **Target Readers**

This manual is for:

• Those who first build an HLS

• Those who first use StepTechnica's various ICs to build an HLS

● **Prerequisites**

This manual assumes that you are familiar with:

• Network technology

• Semiconductor products (especially microcontrollers and memory)

● **Related Manuals**

• Hi-speed Link System Introduction Guide

• Hi-speed Link System Technical Guide

[Caution]

• **To users with *"Hi-speed Link System User's Manual"* released before March, 2001**

Some terms in this manual have been changed to conform to International Standards.

• Some terms in this manual are different from those used on our website and in our product brochures. The brochure uses ordinary terms to help many people in various industries understand our products.

Please understand technical information on HLS Family and CUnet Family based on technical documents (manuals).

■ This manual has been prepared based on Standard English™ meeting the requirements of the International Organization for Standardization (ISO) and the American National Standards Institute (ANSI). This English manual is consistent with the Japanese document **"STD-HLS37-V1.3J"**.

• Standard English is a trademark of Win Corporation.

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This chapter describes the outline of the MKY37 in the Hi-speed Link System (HLS).

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This chapter describes the outline of the MKY37 in the Hi-speed Link System (HLS).

1.1   Role of MKY37

MKY37 is a kind of satellite IC that constitutes the HLS. Be sure to read the *"Hi-speed Link System Introduction Guide"* before understanding the MKY37 and this manual.
The MKY37 must be assigned individual satellite addresses (SAs).

The MKY37 returns a response packet (RP) in response to a command packet (CP), which matches a SA, from the center IC. This causes the status of the input pin (Di) of the MKY37 to be copied directly to the Di area of memory in the center IC. The CP issued from the center IC is embedded with one data item arranged in the Do area of memory in the center IC.

The MKY37 outputs data in the CP from the output pin (Do) of the MKY37 each time a CP matching a SA is input. The center IC periodically transmits and receives a CP to continue scanning the satellite IC. This series of continuous operation links the status of the input pin (Di) of the MKY37 with data in the Di area of memory in the center IC, and data arranged in the Do area of memory in the center IC with the status of the output pin (Do) of the MKY37. The Di and Do areas of memory in the center IC are arranged corresponding to each SA that must be set to the MKY37 (Fig. 1.1).
The MKY37 has some expanded functions in addition to input pin (Di) and output pin (Do) for embedding in various user systems.
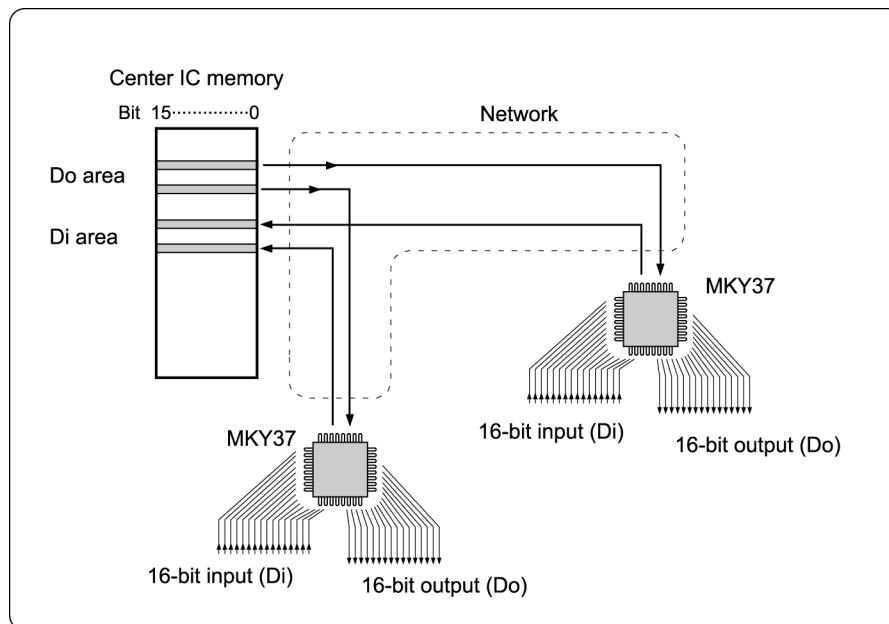
Fig. 1.1   Role of MKY37

1.2 Procedure for Operating MKY37

The MKY37 is a passive IC and it is operated by remote control from center ICs. The user system program (for access to center ICs) to use the MKY37 is very simple.

(1) The user system program just writes data to memory in the center IC when it wants to change the status of the output pin (Do) of the MKY37. For example, when a relay is connected to the output pin (Do), the user system program simply writes data to memory in the center IC only when it wants to turn the relay on or off.

(2) The user system program simply reads memory in the center IC when it wants to obtain the status of the input pin (Di) of the MKY37. For example, when a sensor is connected to the input pin (Di), the user system program can obtain the status of the sensor by reading memory in the center IC.

(3) The user system program can operate the MKY37's expanded functions simply by handling a command in memory in the center IC.

1.3 MKY37 Response Time

In the HLS where a center IC continues to scan, constancy of response time and real-timeness are assured. The time required to link data in memory in the center IC with the states of the input pin (Di) and output pin (Do) of the MKY37 essentially matches the scan time of the HLS, which is very short.

For example, in a user system that must detect the exact position of each box on a belt conveyor, if four MKY37s are connected to the center IC and position detection sensors are connected to the input pins (Di) of all MKY37s, the status of 64 sensors (16 sensors × 4 MKY37s) is stored to memory in the center IC with a scan time interval of 60.7 μs (12 Mbps: full duplex), keeping data up-to-date. This speed remains unchanged even if the farthest MKY37 is 100-m distant. Even if the position detection sensors are placed at every 5 cm, they can detect the position of every box on the belt conveyor without mistakes even when the conveyor runs at 823 m/s (>2900 km/h).

Reference For details of the scan time, refer to *"Scan Time"* in *"User's Manual"* for the center IC connecting the MKY37.

1.4 Features of MKY37

This section describes the basic and the expanded functions of the MKY37.

1.4.1 Features of Basic Functions of MKY37 as Satellite IC in HLS

(1) Has 16 input pins (Di0 to Di15) and 16 output pins (Do0 to Do15)

(2) Supports baud rates of 12, 6, and 3 Mbps

(3) Supports full- and half-duplex modes

(4) Has six pins to set satellite addresses (SA) for any one of 63 terminals at 01H to 3FH

(5) Operates on 5.0-V single power supply and available in 0.5 mm pitch, 64 pins, TQFP

1.4.2 Expanded Functions

(1) Has pin that outputs scan response signals

(2) Has CLR pin that sets output pins (Do0 to Do15) Low

(3) Has strobe output pins that indicate timing to update output pins (Do0 to Do15) and receive input pins (Di0 to Di15)

   The user can design peripheral circuits based on each update timing

(4) Can set handshake to ensure link with center IC

Chapter 2   MKY37 Hardware

This chapter describes the MKY37 hardware, such as pin assignment, pin functions, and I/O circuit types.

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Figure 2.1 shows the MKY37 pin assignment.

MKY37 (64 pins, TQFP)
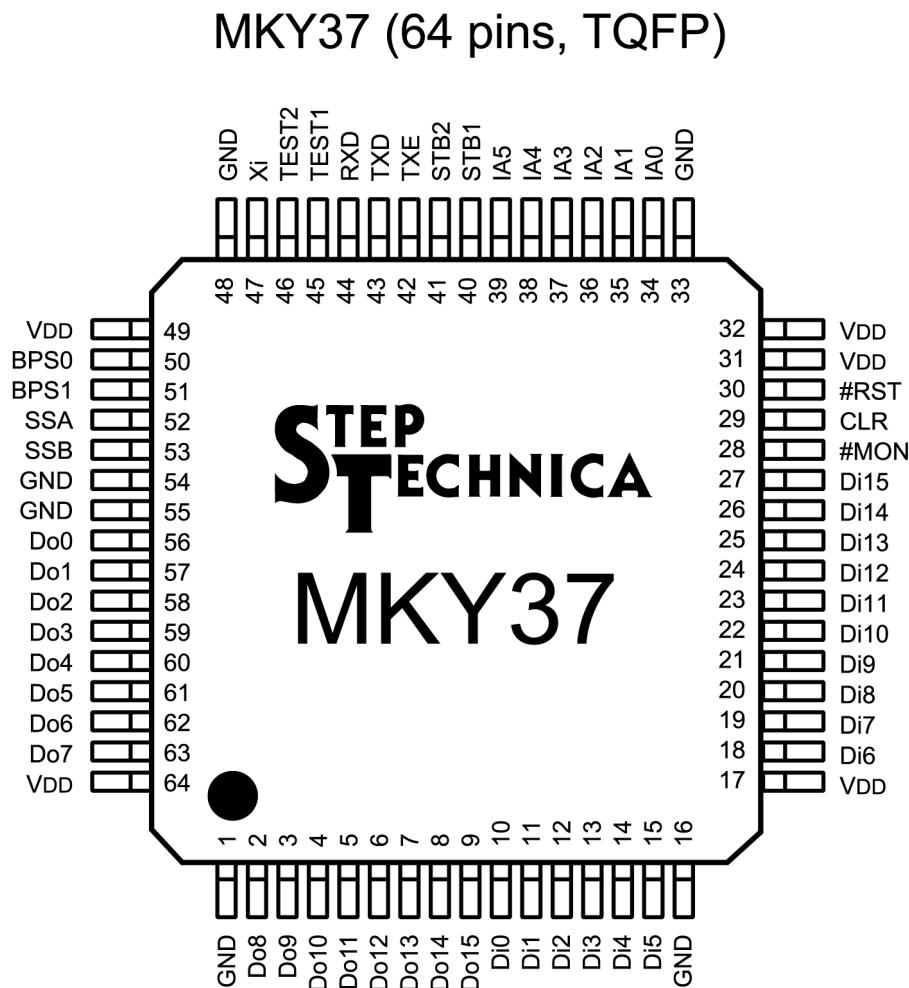
Note: Pins prefixed with # are negative logic (active Low).

Fig. 2.1   MKY37 Pin Assignment

Table 2-1 lists the pin functions of the MKY37.

Table 2-1 Pin Functions of MKY37

Pin name	Pin No.	Logic	I/O	Function
Do0 to Do15	56 to 63 2 to 9	Positive	O	16-bit general-purpose output pins
Di0 to Di15	10 to 15 18 to 27	Positive	I	16-bit general-purpose input pins
#MON	28	Negative	O	Output pin that outputs scan response state of MKY37 Low level is output when a correct scan response is made.
CLR	29	Positive	I	Input pin to forcibly set all output pins (Do0 to Do15) Low Usually, keep this pin Low.
#RST	30	Negative	I	MKY37 Hardware reset input pin Keep this pin Low for 10 or more clocks of the Xi pin frequency right after power-on or when resetting hardware intentionally.
IA0 to IA5	34 to 39	Positive	I	Input pins to assign satellite addresses Set the positive-logic hexadecimal values "1 to 63 (01H to 3FH)" assuming a High level to be "1". A5 is MSB.
STB1	40	Positive	O	Output pin that outputs High-level pulse of strobe signals indicating timing to update state of general-purpose output pins Do0 to Do15 when command packet is input correctly from center IC
STB2	41	Positive	O	Output pin that outputs High-level pulse of strobe signals indicating timing to read state of general-purpose input pins (Di0 to Di15)
TXE	42	Positive	O	Output pin that goes High while outputting response packet to center IC Connect this pin to the enable input pin of a driver.
TXD	43	Positive	O	Pin that outputs response packet to center IC Connect this pin to the drive input pin of a driver.
RXD	44	Positive	I	Input pin that inputs command packet from center IC Connect this pin to the output pin of a receiver.
TEST1 TEST2	45 46	Positive	I	Be sure to connect this pin to GND (manufacturer test pin)
Xi	47	Positive	I	Pin for connection of generated clock
BPS0	50	Positive	I	Input pin that selects baud rate of MKY37. For details, see *"3.1.2 Setting Baud Rate"*.
BPS1	51	Positive	I	Input pin that selects baud rate of MKY37. For details, see *"3.1.2 Setting Baud Rate"*.
SSA	52	Positive	I	Input a High or Low level for selection of strobe signal functions to this pin. For details, see *"4.2.3 Setting Strobe Signal Timing"*.
SSB	53	Positive	I	Input a High or Low level for selection of strobe signal functions to this pin. For details, see *"4.2.4 Enabling/Disabling Handshake"*.

(Continue)

Table 2-1 Pin Functions of MKY37

(Continued)

Pin name	Pin No.	Logic	I/O	Function
V$_{DD}$	17, 31 32, 49 64	---	---	Power pin connected to 5.0 V
GND	1, 16 33, 48 54, 55	---	---	Power pin connected to 0 V

Note: Pins prefixed with # are negative logic (active Low).

Table 2-2 and Figure 2.2 shows the electrical ratings of the MKY37 pins.

Table 2-2 Electrical Ratings of MKY37

(#: Negative logic)

No	I/O	Name	Type	No	I/O	Name	Type	No	I/O	Name	Type	No	I/O	Name	Type
1	--	GND	--	17	--	VDD	--	33	--	GND	--	49	--	VDD	--
2	O	Do8	B	18	I	Di6	A	34	I	IA0	D	50	I	BPS0	C
3	O	Do9	B	19	I	Di7	A	35	I	IA1	D	51	I	BPS1	C
4	O	Do10	B	20	I	Di8	A	36	I	IA2	D	52	I	SSA	D
5	O	Do11	B	21	I	Di9	A	37	I	IA3	D	53	I	SSB	D
6	O	Do12	B	22	I	Di10	A	38	I	IA4	D	54	--	GND	--
7	O	Do13	B	23	I	Di11	A	39	I	IA5	D	55	--	GND	--
8	O	Do14	B	24	I	Di12	A	40	O	STB1	B	56	O	Do0	B
9	O	Do15	B	25	I	Di13	A	41	O	STB2	B	57	O	Do1	B
10	I	Di0	A	26	I	Di14	A	42	O	TXE	B	58	O	Do2	B
11	I	Di1	A	27	I	Di15	A	43	O	TXD	B	59	O	Do3	B
12	I	Di2	A	28	O	#MON	B	44	I	RXD	D	60	O	Do4	B
13	I	Di3	A	29	I	CLR	D	45	I	TEST1	D	61	O	Do5	B
14	I	Di4	A	30	I	#RST	C	46	I	TEST2	D	62	O	Do6	B
15	I	Di5	A	31	--	VDD	--	47	I	Xi	E	63	O	Do7	B
16	--	GND	--	32	--	VDD	--	48	--	GND	--	64	--	VDD	--

Type-A   TTL level input Schmitt trigger
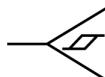
Vt+ max	2.2	V
Vt- min	0.76	V
ΔVt min	0.2	V
IIH (VIH: VDD) max	100	μA
IIL (VIL: VSS) max	-100	μA

Type-B   Push-pull output

-8mA
8mA
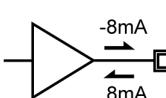
VOH (IOH: -100μA) min	VDD-0.2	V
VOH (IOH: -8mA) min	3.7	V
VOL (IOL: 100μA) max	0.2	V
VOL (IOL: 8mA) max	0.44	V
IOH max	-8	mA
IOL max	8	mA

Type-C   Pull-up input
(Schmitt trigger for TTL level input)
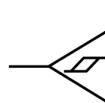
Rpu typ 50kΩ

Vt+ max	2.2	V
Vt- min	0.76	V
ΔVt min	0.2	V
IIH (VIH: VDD) max	100	μA
IIL (VIL: VSS) max	-250	μA

Type-D   Pull-down input
(Schmitt trigger for TTL level input)
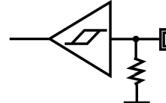
Rpd typ 50kΩ

Vt+ max	2.2	V
Vt- min	0.76	V
ΔVt min	0.2	V
IIH (VIH: VDD) max	250	μA
IIL (VIL: VSS) max	-100	μA

Type-E   TTL level input
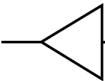
|		
VIH min	2.2	V
VIL max	0.76	V
IIH (VIH: VDD) max	100	μA
IIL (VIL: VSS) max	-100	μA

Fig. 2.2   Pin Electrical Characteristics in I/O Circuit Types of MKY37

Chapter 3 Connecting Basic Functions of MKY37

This chapter describes the pin functions and connections required to operate the basic functions of the MKY37.

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3.1   Driving Clock

This section describes the MKY37 driving clock.

3.1.1   Supplying Generated Driving Clock

An oscillator-generated external clock can be supplied directly to the MKY37 and used as the driving clock. To supply the external clock directly to the MKY37, use the Xi pin (pin 47). The specifications for direct supplying the external clock are as follows:

  (1) The upper frequency is 50 MHz and a lower frequency is not provided.

  (2) Electrical characteristics of the Xi pin: V_{IH} = min. 2.2 V, V_{IL} = max. 0.76 V

  (3) Clock with a signal rise and fall times of 20 ns or less

  (4) Clock with a minimum High-level or Low-level time of 5 ns or more

  (5) Clock with jitter component of:

   • Within 250 ps when input frequency is 25 MHz or more

   • Within 500 ps when input frequency is less than 25 MHz

  (6) Frequency accuracy of ±1000 ppm (±0.1%) or better

Reference   For a commonly-used oscillator, there is no problem with clock output by the values above in (2) to (6).

3.1.2   Setting Baud Rate

Baud rate of MKY 37 is set by setting BPS0 pin (pin 50) and BPS1 pin (pin 51). Table 3-1 shows baud rate corresponding to setting of BPS0 and BPS1 pins when an external clock of 48 MHz is connected to Xi pin. Set both BPS0 and BPS1 pins so that they will conform to baud rate of HLS center IC to which MKY 37 is connected.

Table 3-1 Baud Rate at 48 MHz of Driving Clock

BPS1 pin	BPS0 pin	Baud rate
Hi	Hi	12 Mbps
Hi	Lo	6 Mbps
Lo	Hi	3 Mbps
Lo	Lo	1.5 Mbps

3.2 Hardware Reset

When a Low level is input to the #RST (ReSeT) pin (pin 30), the MKY37 is hardware-reset. If a period in which the Low-level signal has been input is less than "one clock", the signal is ignored to prevent malfunction. To reset the MKY37 completely, the #RST pin must be kept Low for "10 or more clock" while supplying a driving clock. The #RST pin is connected to an internal Schmitt-type input buffer, so a constant-rise-time circuit can be connected directly at power-on (Fig. 3.1).
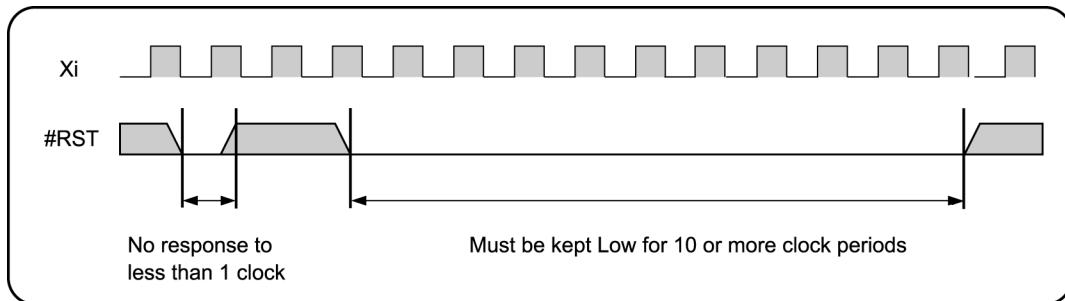

Fig. 3.1   Hardware Reset

| Caution | Design the circuit so that a hardware reset is surely activated immediately after MKY37 power-on. |

3.3   Setting Satellite Addresses

The MKY37 has six satellite address (SA) setting pins (IA0 to IA5: Input Addresses 0 to 5). Individual satellite addresses (SA) must be assigned to each satellite IC when using the HLS. To set the SA values to the MKY37, use hexadecimal numbers from 01H to 3FH (addresses 1 to 63) assuming a High level is input to IA0 to IA5 (pins 34 to 39) as "1" and a Low level is input as "0". The most significant bit is IA5 (pin 39). These SA settings correspond to the memory addresses in each area in the center IC.

- **Example 1:**   **The state of the input pin (Di) of the MKY37 at SA = 1 (01H) is stored at address 02H in the Di area of memory in the center IC.**
- **Example 2:**   **The state of the input pin (Di) of the MKY37 at SA = 63 (3FH) is stored at address 7EH in the Di area of memory in the center IC.**
- **Example 3:**   **The data at memory address 9CH in the Do area in the center IC is output to the output pin (Do) of the MKY37 at SA = 14 (0EH).**

Reference   There are no limitations on physical network arrangement, such as setting the SA values in the order in which they are closer to the center IC. If the center IC has two input pins (RXD1 and RXD2), there are no rules, such as which pin (network) the MKY37 in which specific SA values are set is connected to.

Caution   The different SA values must be set to all satellite ICs connected to one center IC. The SA value cannot be set to 00H. Even if the SA value of 00H is set to a satellite IC by mistake, the system is not adversely affected but the satellite IC is not scanned by the center IC.

3.4   Connecting Network Interface

The network interface (network I/F) pins of the MKY37 consist of RXD (pin 44), TXE (pin 42), and TXD (pin 43).

3.4.1 Details of RXD, TXE, and TXD Pins

In the MKY37, the RXD pin inputs a command packet (CP) from the center IC. Connect the TRX (driver/ receiver components) in the network so that a serial pattern signal for the command packet (CP) transmitted from the center IC will be input to the RXD pin.

If the address of the input CP matches the SA set by IA0 to IA5, the MKY37 immediately returns a response packet (RP) to the center IC. The TXE pin goes High while the MKY37 sends the RP. When the TXE pin goes High, design the TRX so that the enable pin of the TRX driver is activated, thereby enabling the serial pattern signal for the RP output from the TXD pin to be transmitted to the network.
When the hardware reset is activated, the TXE and TXD pins go Low level immediately.

Reference When the HLS operates in half-duplex mode, the signal output from the TXD pin of the MKY37 may be input directly to the RXD pin while the MKY37 is returning the RP. The MKY37 is designed not to input data when the TXE pin is High, so there is no problem.

3.4.2 Recommended Network Connection

Figure 3.2 shows the recommended network connection. The TRX (driver/receiver components) consists of an RS485-based driver/receiver (LSI driven at 5.0 V) and pulse transformer. Recommended network cables include Ethernet LAN network cables (10BASE-T, Category 3 or higher) and shielded network cables. When operating the HLS, full-duplex mode requires two twisted-pair cables, and half-duplex requires one twisted-pair cable (Fig. 3.2).
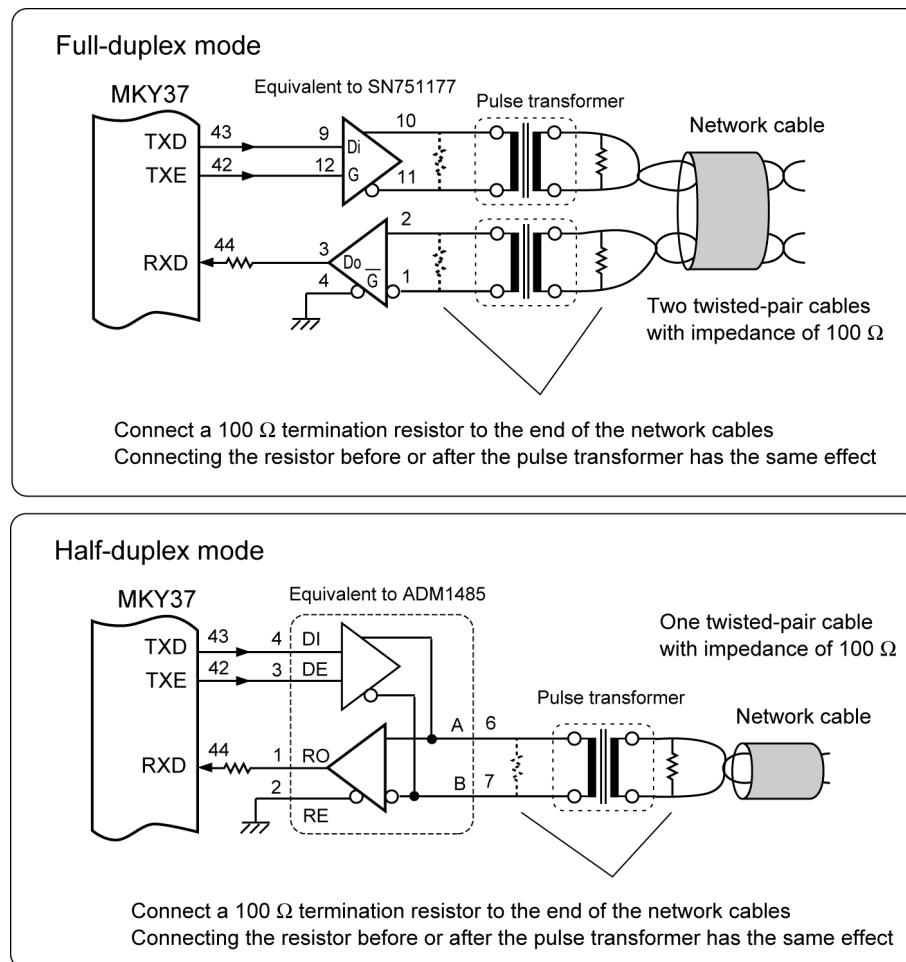
Fig. 3.2 Recommended Network Connection

3.5   16 Input Pins (Di)

The MKY37 has 16 input pins (Di0 to Di15). The state of the input pins is copied directly to the memory address corresponding to the SA in the Di area in the center IC. Di0 (pin 10) corresponds to data bit 0 and Di15 (pin 27) corresponds to data bit 15, which link as 16-bit word data to memory in the center IC. This 16 input pins have Schmitt-type input buffers and can be connected directly to time-constant circuits for chattering prevention.

The MKY 37 samples the state of the 16 input pins when a command issued from the center IC is "0" or "8". When other commands (1 to 7 and 9 to 14) are issued, the MKY37 does not sample the state of their input pins and data stored in response packet is fixed at "0000H". Table 3-2 shows correspondence of commands issued from the center IC.

Table 3-2 Correspondence of Commands Issued from Center IC

Command	Function of MKY37	Data stored in response packet	Memory area in Center IC
0 (0H)	Samples Di0 to Di15 pin states	State of Di0 to Di15 pins	Di
1 (1H) to 7 (7H)	Does not sample (STB2 not output)	0000H	C1 to C7
8 (8H)	Samples Di0 to Di15 pin states	State of Di0 to Di15 pins	Di
9 (9H) to 14 (EH)	Does not sample (STB2 not output)	0000H	C1 to C7

Caution   If any I/O input pins among 16 input pins of MKY37 are unused in the user system, they cannot be left open. Fix them at High or Low (pins to be used for future should be connected to a pull-up or pull-down resistor). When a command in the command packet (CP) issued from the center IC is not "0" or "8" (basic function specified), data of 16 input pins is not sent to the Di area.

3.6 16 Output Pins (Do)

The MKY37 has 16 output pins (Do0 to Do15). When the MKY37 inputs the CP correctly which contains one piece of the data in the Do area in the center IC (memory) issued from the center IC, and when the address of the CP matches the SA set by IA0 to IA5, the MKY37 outputs (updates) the data contained in the CP to the output pins (Do0 to Do15) of the MKY37. The data output to the I/O output pins is kept until next updated. The Do0 (pin 56) corresponds to bit 0 of the 16-bit word data in the Do area in the center IC (memory) and Do15 (pin 9) to bit 15.

When a hardware reset is activated, the output pins (Do0 to Do15) go Low level immediately.
The output pins go Low without keeping data when High level is input to the CLR pin described in *"4.1.4 CLR Pin Function"*.

The Do0 to Do15 pins of the MKY37 have a drive capacity of ±8 mA (max.) and can be connected directly to peripheral components such as transistors, LEDs, and photocouplers.

Reference There is no problem if any unused pins of the Do0 to Do15 pins are left open.

3.7 Connection Example of MKY37 Basic Functions

Figure 3.3 shows a connection example of MKY37 basic functions. In the example circuit, all the expanded functions described later are unused. The satellite addresses of the MKY37 can be set by DIP-Switch (DIP-SW).
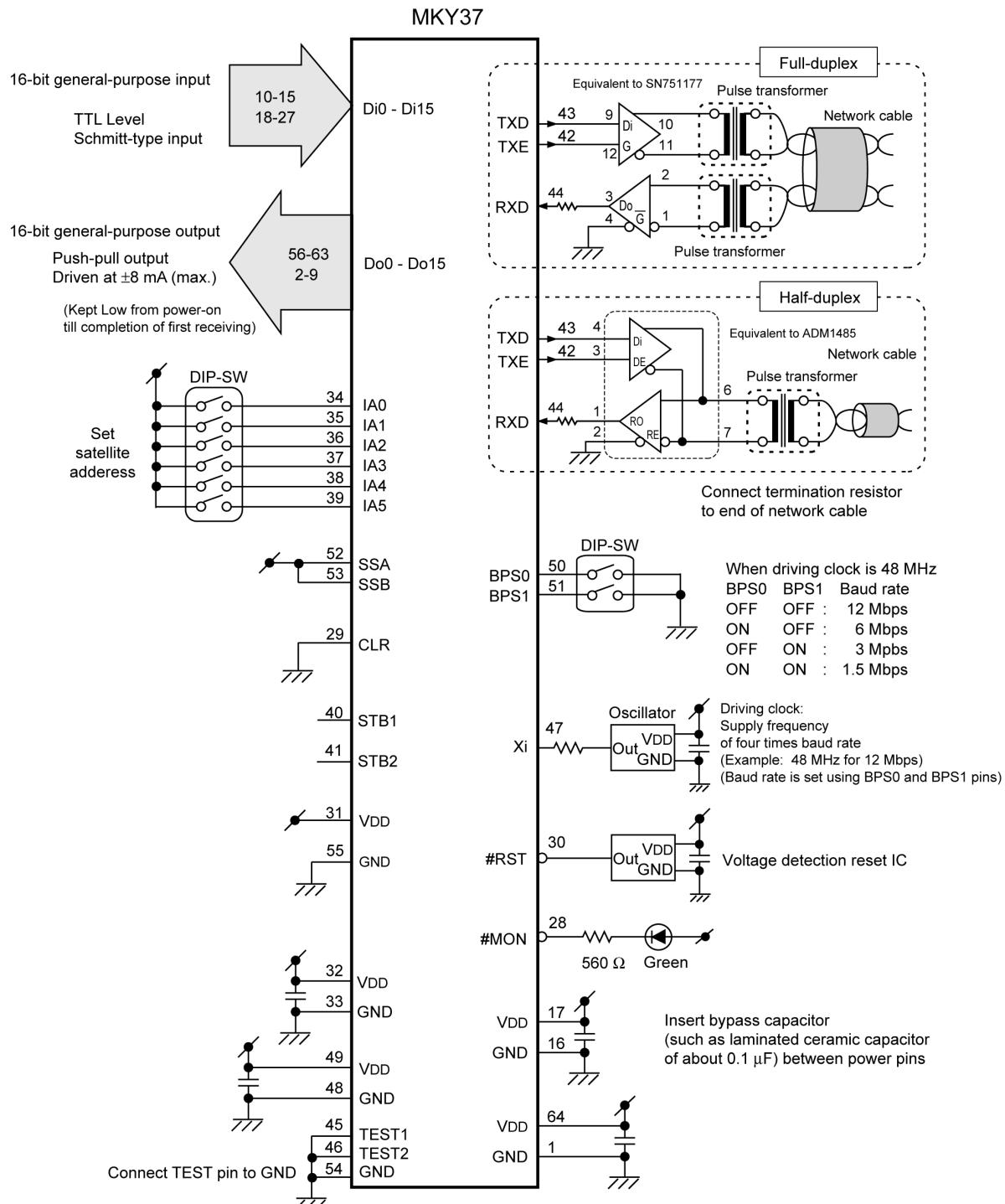

Fig. 3.3 Connection Example of Basic Functions

Chapter 4   Expanded Functions of MKY37

This chapter describes the pin functions and connections required to operate the expanded functions of the MKY37.

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4.1   Scan Response Signals and Its Applications

This section describes how to use the following two functions among the expanded functions described in *"1.4.2 Expanded Functions"*:

   (1) Has pin that outputs scan response signals

   (2) Has CLR pin that sets output pins (Do0 to Do15) Low

4.1.1   Function of #MON Pin

The MKY37 has a #MON pin (pin 28) that outputs scan response signals.

The #MON pin operates as follows by a retriggerable one-shot multivibrator circuit in the MKY37:

   (1) The #MON pin goes High when hardware reset becomes activated

   (2) And then, when the #MON pin receives correctly a command packet (self-addressed CP) from the center IC transmitted to the terminal matching SA (Satellite Address) that was set using IA0 to IA5 pins, it goes Low

   (3) After that, when the #MON pin cannot receive self-addressed CP within a given time, it goes High

The "given time" means "$130560 \times T_{BPS}$". Table 4-1 lists the given time for the baud rate.

Table 4-1 Given Time for #MON Pin to Change to High

Baud rate	Given time
12 Mbps	10.88 ms
6 Mbps	21.76 ms
3 Mbps	43.52 ms
1.5 Mbps	87.04 ms
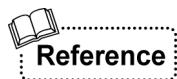
Reference In a user system using output signals from the #MON pin as time-up signals for a watchdog timer, set the time shown in Table4-1 as the time-up.

4.1.2 Indication of Scan Response

When the LED that goes on at a Low level is connected to the #MON pin (pin 28), it indicates that the MKY37 has responded to a scanning from the center IC. The #MON pin has a drive capacity of ±8 mA. If the LED can go on even at 8 mA or less, the connection in Figure 4.1 is possible. In this case, the hardware designer of the terminal with the MKY37 needs to determine the current-limiting resistor value according to the LED rating.


Fig. 4.1   Indication of Scan Response

StepTechnica recommends a green LED indicating stability be connected to the #MON pin. When not used, leave this pin open.
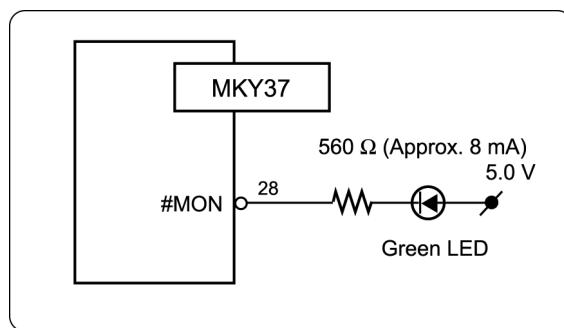
4.1.3 Watchdog Timer

The function of the #MON pin changing from Low to High after the given time has elapsed (time-up) can be used as a watchdog timer for the terminal with the MKY37 embedded.

Generally, the time-up time of a watchdog timer needs to be set longer than the allowable time of multiple scan times. However, the time-up time of the #MON pin may be inappropriate in the following cases:

(1) For the user system where HUBs are inserted into network (One scan time increases according to the inserted number of HUBs.)

(2) When user program operating center IC pauses scanning

(3) When user program operating center IC uses single scan and starts single scan according to inappropriate timing for time-up time of watchdog timer

(4) When user program operating center IC stops scanning intentionally

The user should determine whether the time-up time of the #MON pin is appropriate for the user system.

📖 **Reference**   For details of the scan time, scan pausing, and single scan, refer to **"User's Manual"** for the center IC that the MKY37 is connected to.

4.1.4 CLR Pin Function

The MKY37 has a CLR (CLeaR) pin (pin 29) that forcibly sets the output pins (Do0 to Do15) Low. When a High level is input to the CLR pin, all the states of the output pins go Low. In normal operation, design so that a Low level is input to the CLR pin. If a period in which the High-level signal has been input is less than "T$_{BPS}$ time", the signal is ignored to prevent malfunctions.

The state of the output pins (Do) of the MKY37 is updated each time the command packet (CP) from the center IC transmitted to the terninals matching the SAs set by the IA0 to IA5 pins is received correctly. However, if scanning is stopped for reasons such as the disconnection of a network cable or center IC faults, the state of the output pins (Do) is retained continuously.

When a user system cannot retain the state of the output pin appropriately when scanning is stopped, the MKY37 can use the CLR pin to forcibly clear the state of the output pins (Low level). Figure 4.2 shows a circuit example that clears the state of the output pins by connecting the signal from the #MON pin to the CLR pin.
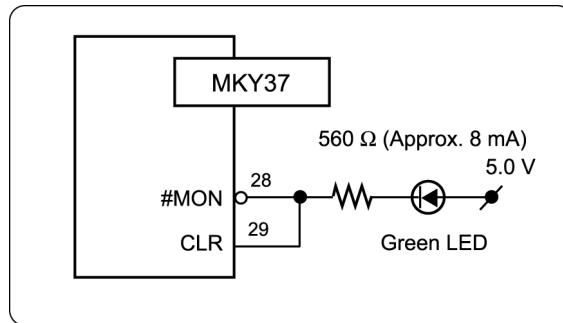

Fig. 4.2   Connection Example between #MON Pin and CLR Pin

☞ **Caution** Read and understand the description in *"4.1.3 Watchdog Timer"* before using this circuit example.

4.2 Setting Strobe Signal and Its Application

This section describes how to use the following three functions among the expanded functions described in *"1.4.2 Expanded Functions"*:

(3) Has strobe output pins that indicate timing when to update output pins (Do0 to Do15) and receive input pins (Di0 to Di15)

The user can also design peripheral circuit based on each update timing.

(4) Can set handshake to ensure link with center IC

4.2.1 STB1 Pin Function

Each time the MKY37 inputs the command packet (CP) matching the SA from the center IC correctly, it outputs data in the CP to the output pin (Do) of the MKY37. The state of the output pin (Do) is updated at the central timing of the pulse-like strobe signal from the STB1 (STroBe-1) pin (pin 40) (Fig. 4.3). The function of this STB1 pin can be used to notify a circuit connected to the output pin (Do) that the output state is updated.


The state of the output pin (Do) is updated at the central timing of STB1 signal

Do0-15 | Previous Do data | New Do data

Passage of time

STB1

TOE

TSTB

TSTB is $2 \times$ TBPS (333.3 ns at 6 Mbps)
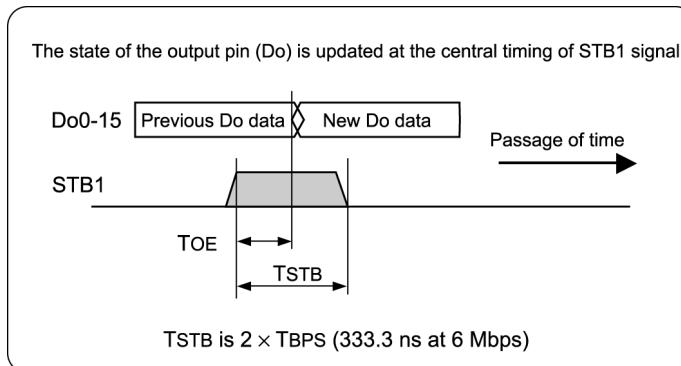
Fig. 4.3 Update Timing of Output Pin (Do)

Reference The pulse-like strobe signal output from the STB1 pin is unaffected by the command value of the center IC. The strobe signal is also output from the STB1 pin if the state of the output pin (Do) after updating is identical to that before updating.

4.2.2 Time to Sample State of Di0 to Di15 Pins (STB2 Pin)

If the command in the CP issued from the center IC is "0" or "8" (basic function specified) when the response packet (RP) is returned in response to the command packet (CP) matching the SA, the MKY37 samples the 16 input pins (Di0 to Di15). The MKY37 outputs a pulse-like strobe signal from the STB2 (STroBe-2) pin (pin 41) to indicate the time to sample the state of the input pin (Di). The state of the input pin (Di) is sampled at the center of the strobe signal.

Reference When the SSB (Strobe Select-B) pin described in *"4.2.4 Enabling/Disabling Handshake (SSB Pin)"* is Low, no strobe signal may be output from the STB2 pin when the MKY37 returns the RP.

4.2.3 Setting Strobe Signal Timing (SSA Pin)

The following two requests occur in the user system using the HLS:

(1) To update state of output pin (Do) after sampling input state of input pin (Di).

(2) To sample state of input pin (Di) after updating state of output pin (Do).

In the MKY37, the user can select the timing of strobe signals output from the STB1 pin and STB2 pin by setting the SSA (Strobe Select-A) pin (pin 52). This will enable to meet the two requests. The MKY37 performs the operation in (1) above when the SSA pin is set Low, and the operation in (2) above when the SSA pin is set High (Fig. 4.4).
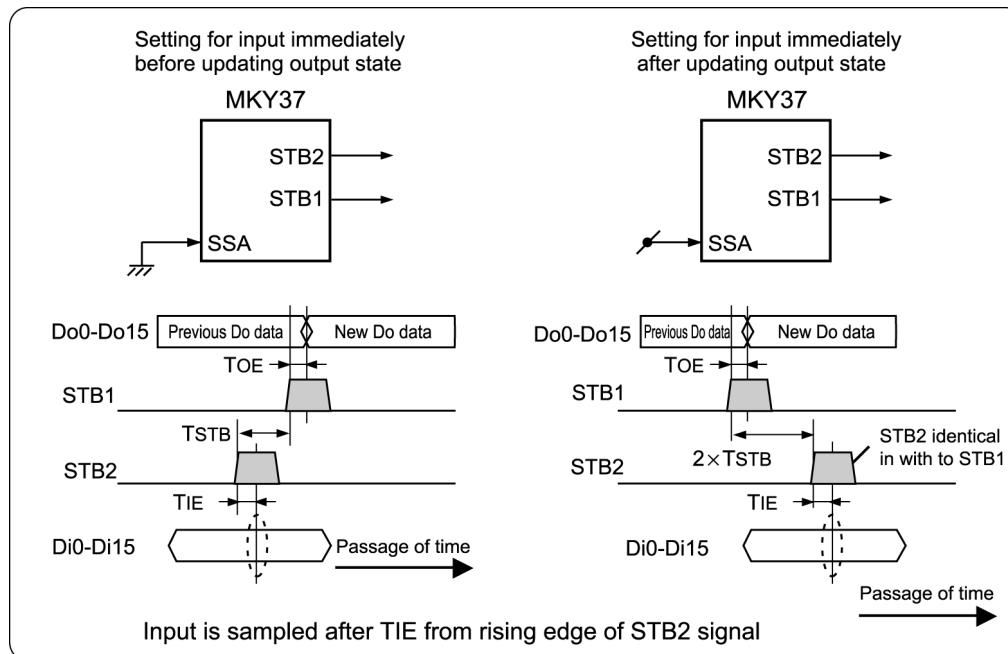

Fig. 4.4   SSA Pin Setting and Update Timing

4.2.4 Enabling/Disabling Handshake (SSB Pin)

Handshaking with the center IC can be enabled or disabled by setting the SSB (Strobe Sdect-B) pin (pin 53). When the SSB pin is Low, handshaking with the center IC is enabled.

When the MKY37 inputs the command packet (CP) from the center IC, it recognizes whether the center IC has received correctly the response packet (RP) returned to the center IC at the last scan. In a case where handshaking is enabled, the MKY37 outputs a strobe signal from the STB2 pin to sample the state of the input pin (Di) only when the center IC has input the previously returned RP correctly, and the sampled state of the input pin (Di) is embedded in the RP.

If the center IC has not input the previously returned RP correctly, the MKY37 neither outputs a strobe signal to the STB2 pin nor samples the state of the input pin (Di). In this case, the previously sampled stated of the input pin (Di) is embedded in the RP again. Figure 4.5 shows the timing of generating the STB2 strobe signal in the MKY37 with five satellites and "SA = 2" in half-duplex mode.
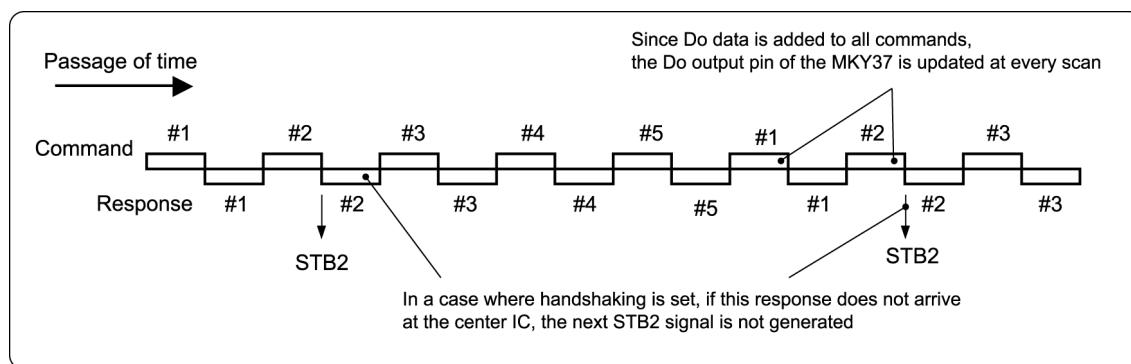

Fig. 4.5   Timing of STB2 Strobe Signal Generation

📖 **Reference**   In a user system in which real-timeness is essential when a sensor is connected to the input pin (Di), and so on, disable handshaking.

4.2.4.1 Example of Handshaking Effectiveness

This section describes an example of the effectiveness of handshaking with the center IC.

Some user systems may want to send character string data to the center IC in synchrony with the strobe signal output from the STB2 pin. For example, when transferring character string data consisting of the 5 characters **"ABCDE"** to the input pin (Di) of the MKY37 at each output of the STB2 strobe signal (Fig. 4.6A), a character may be omitted in the character string data obtained by the center IC when handshaking with the center IC is disabled. For example, if there is interference including external noise in the network during sending the letter **"C"** and the RP is discarded at the center IC, the STB2 strobe signal is output at the next scan. Consequently, the center IC receives the character string data **"ABDE"** (**"C"** omitted) (Fig. 4.6B).

Fig. 4.6A   Operation with No Failure

In contrast, when handshaking is enabled, the STB2 strobe signal is not output at the next scan even when the RP is discarded at the center IC and character will not be omitted (Fig. 4.6C).
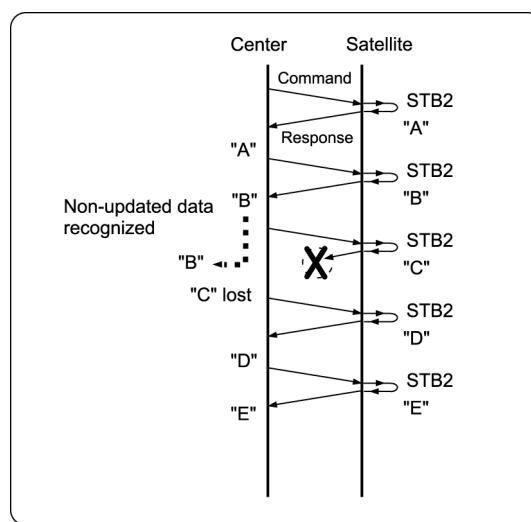

Fig. 4.6B   Handshaking Disabled
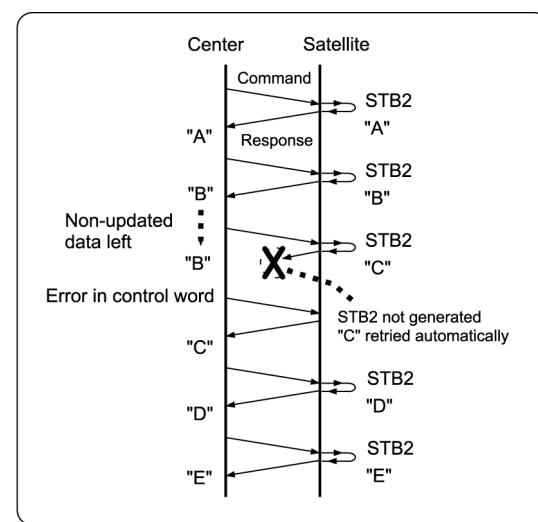
Fig. 4.6C   Handshaking Enabled

4.2.4.2 Cautions for Sending Character String Data

This section describes the cautions for sending character string data when handshaking is enabled with the SSB pin set Low.

As described previously, enabling handshaking ensures that character string data is sent (without omitting character) to memory in the center IC. In this case, the user system program of the center IC must obtain character string data from memory in synchronization with scan timing. For the example in Figure 4.6C, note the following:

(1) If character string data is simply obtained from memory in synchronization with the scan timing, character string data including duplicated characters like **"ABBCDE"** may be read (because the third character cannot reach at the third scan).

(2) At the third scan, the corresponding satellite IC causes an error (that can be recognized by a nonresponding flag bit in the control word in the center IC).

(3) If the above error occurs, ideally it should be handled by the algorithm that does not read data. However, since scanning is very fast and such handling must be set for each satellite IC, program execution speed may not follow scan speed.

Based on the above cautions, a method for easily creating the program algorithm for the center IC is shown below.

The input pin (Di) consists of 16 pins. If eight pins are used to input a character code (8-bit information), eight pins are left. When a "character counter" is used for these eight input pins (Di), the program algorithm for the center IC can be created easily. Figure 4.7 shows a example of using the high-order one byte (8 bits) of data as a character counter.
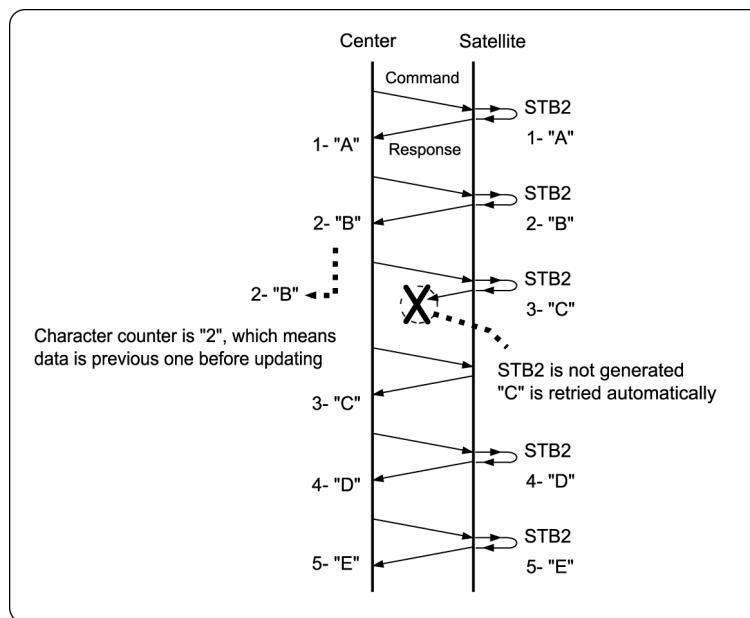

Fig. 4.7   Sending with Character Counter Used

4.2.4.3 Caution for Using Handshaking (1)

In the HLS, the handshaking function is intended to send data sampled by the satellite IC to the center IC without loss. This will cause a difference in data arrival at the center IC between when an error occurs in the response packet and when an error occurs in the command packet.

An example of sending character string data is shown. If an error occurs in the response packet (Figs. 4.6C and 4.7), the letter **"C"** does not arrive at link failure and does arrive at the next normal scan. In contrast, if an error occurs in the command packet (Fig. 4.8), the letter **"B"** arrives at the center IC twice at the scan before or after link failure.
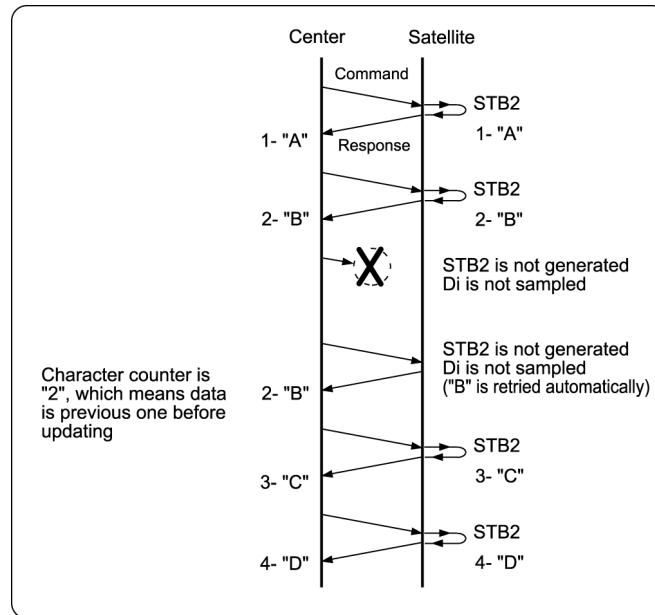

Fig. 4.8   Operation at CP Failure

As shown in this example, in both cases, the data sampled by the satellite IC is sent to the center IC without loss. However, based on the difference in data arrival at the center IC, the user system program must handle data in the center IC (memory). Placing a character counter of at least two or more bits as described in *"4.2.4.2 Cautions for Sending Character String Data"* near the MKY37 can help the user system program to deal with to this problem.

4.2.4.4 Caution for Using Handshaking (2)

When the SSB pin (pin 53) is set to enable the handshaking, and when the user system executes commands other than "0" or "8" (basic function specified) for the MKY37, no strobe signal is output from the STB2 pin.

Chapter 5   Ratings

This chapter describes the ratings of the MKY37.

Chapter 5 Ratings

This chapter describes the ratings of the MKY37.

5.1 Electrical Ratings

Table 5-1 lists the absolute maximum ratings of the MKY37.

Table 5-1 Absolute Maximum Ratings (Vss = 0 V)

Parameter	Symbol	Rating	Unit
Power supply voltage	V_{DD}	-0.5 to +6.5	V
Input voltage	Vi	V_{SS}-0.5 to V_{DD}+0.5	V
Output voltage	Vo	V_{SS}-0.5 to V_{DD}+0.5	V
Peak output current	Iop	Peak ±26	mA
Allowable power dissipation	PT	345	mW
Operating temperature	Topr	-40 to +85	°C
Storage temperature	Tstg	-65 to +150	°C

Table 5-2 lists the electrical ratings of the MKY37.

Table 5-2 Electrical Ratings (T_A = 25 °C   Vss = 0 V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating power supply voltage	V_{DD}	---	4.5	5.0	5.5	V
Mean operating current	V_{DDA}	Vi = V_{DD} or Vss Xi = 48 MHz output open	---	15	20	mA
		Vi = V_{DD} or Vss Xi = 24 MHz output open	---	7.5	10	mA
External input frequency	Fclk	Input to Xi pin	---	---	50	MHz
Input pin capacitance	Ci	V_{DD} = Vi = 0 V f = 1 MHz T_A = 25°C	---	6	---	pF
Output pin capacitance	Co		---	9	---	pF
Rise/fall time of input signal	T_{IRF}	---	---	---	20	ns
Rise/fall time of input signal	T_{IRF}	Schmitt trigger input	---	---	30	µs

参 考 The following table shows mean operating current and baud rate selected for input clock to the Xi pin.

| Input to Xi pin	Baud rate	Typ.	Max.	Min.	Remarks	
					BPS1	BPS0
48 MHz	12 Mbps	15	20	mA	Hi	Hi
	6 Mbps	8.5	11	mA	Hi	Lo
	3 Mbps	5.5	7.5	mA	Lo	Hi
	1.5 Mbps	4	5.5	mA	Lo	Lo
24 MHz	6 Mbps	7.5	10	mA	Hi	Hi
	3 Mbps	4.5	6	mA	Hi	Lo
	1.5 Mbps	3	4	mA	Lo	Hi
12 MHz	3Mbps	3.5	4.1	mA	Hi	Hi
	1.5Mbps	2.5	3.5	mA	Hi	Lo

5.2 AC Characteristics

Table 5-3 lists the measurement conditions for AC characteristics of the MKY37.

**Table 5-3 AC Characteristics Measurement Conditions**

Symbol	Name	Value	Unit
C_{OL}	Output load capacitance	80	pF
V_{DD}	Power supply voltage	5.0	V
T_A	Temperature	25	°C

5.2.1 Clock and Reset Timing (#RST, Xi)
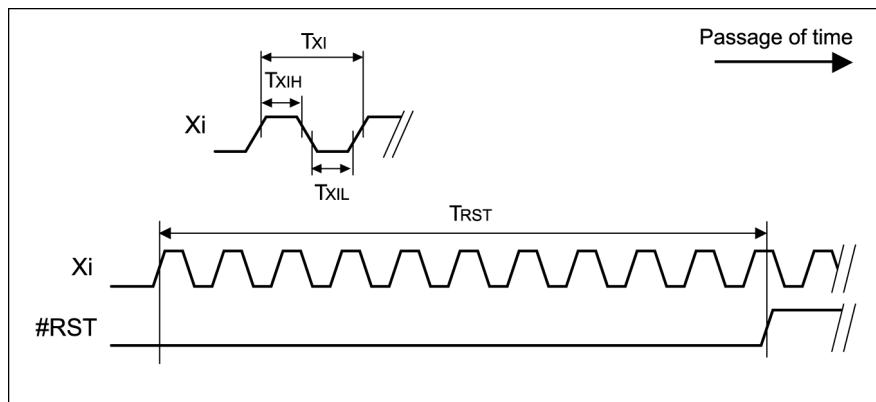
Symbol	Name	Min.	Max.	Unit
T_{XI}	Clock period width	20	---	ns
T_{XIH}	Clock High level width	5	---	ns
T_{XIL}	Clock Low level width	5	---	ns
T_{RST}	Reset enable Low level width	$10 \times T_{XI}$	---	ns

5.2.2 Baud Rate Timing (TXE, TXD, RXD)
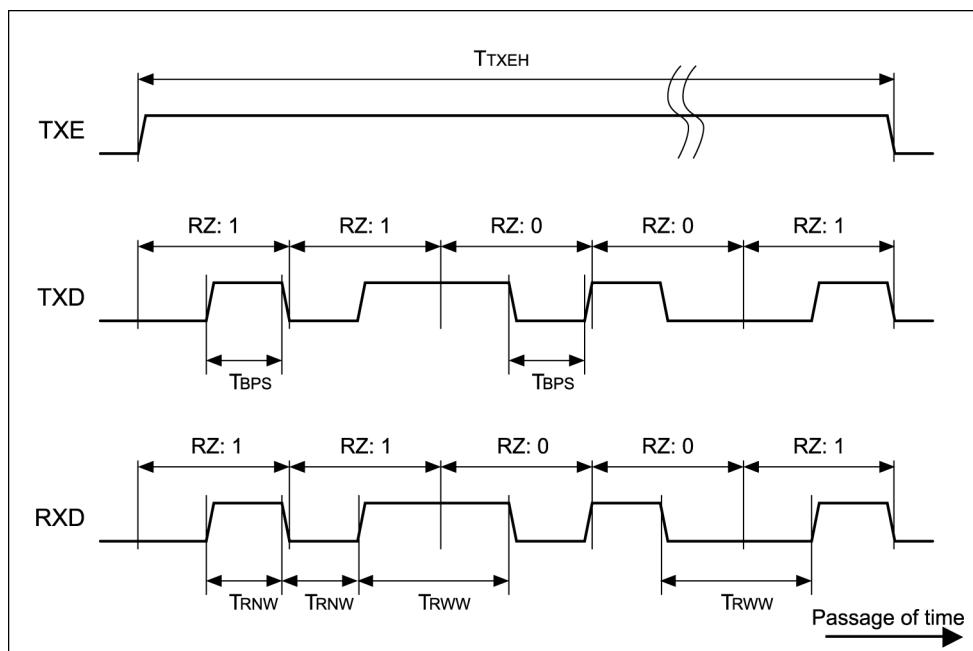
Symbol	Name	Baud rate	Short pulse width of sending signal	Unit	Remarks
T_{BPS}	Short pulse width of sending signal	12 Mbps	$\approx 83.33 \pm 5$	ns	Baud rate is determined by inputting Xi pin and setting BPS0 and BPS1 pins
		6 Mbps	$\approx 166.67 \pm 5$	ns	
		3 Mbps	$\approx 333.33 \pm 5$	ns	
		1.5 Mbps	$\approx 666.67 \pm 5$	ns	

Symbol	Name	Min.	Typ.	Max.	Remarks
T_{TXEH}	Period in which TXE pin goes High	$(142 \times T_{BPS}) - 5ns$	$142 \times T_{BPS}$	$(142 \times T_{BPS}) + 5ns$	--------
T_{RNW}	Short pulse width of input signal	$0.51 \times T_{BPS}$	$1.0 \times T_{BPS}$	$1.49 \times T_{BPS}$	Allowable pulse width as RZ signal
T_{RWW}	Long pulse width of input signal	$1.51 \times T_{BPS}$	$2.0 \times T_{BPS}$	$2.49 \times T_{BPS}$	Allowable pulse width as RZ signal

5.2.3 Strobe/I/O Pin Timing (Do0 to Do15, STB1, Di0 to Di15, STB2, CLR)
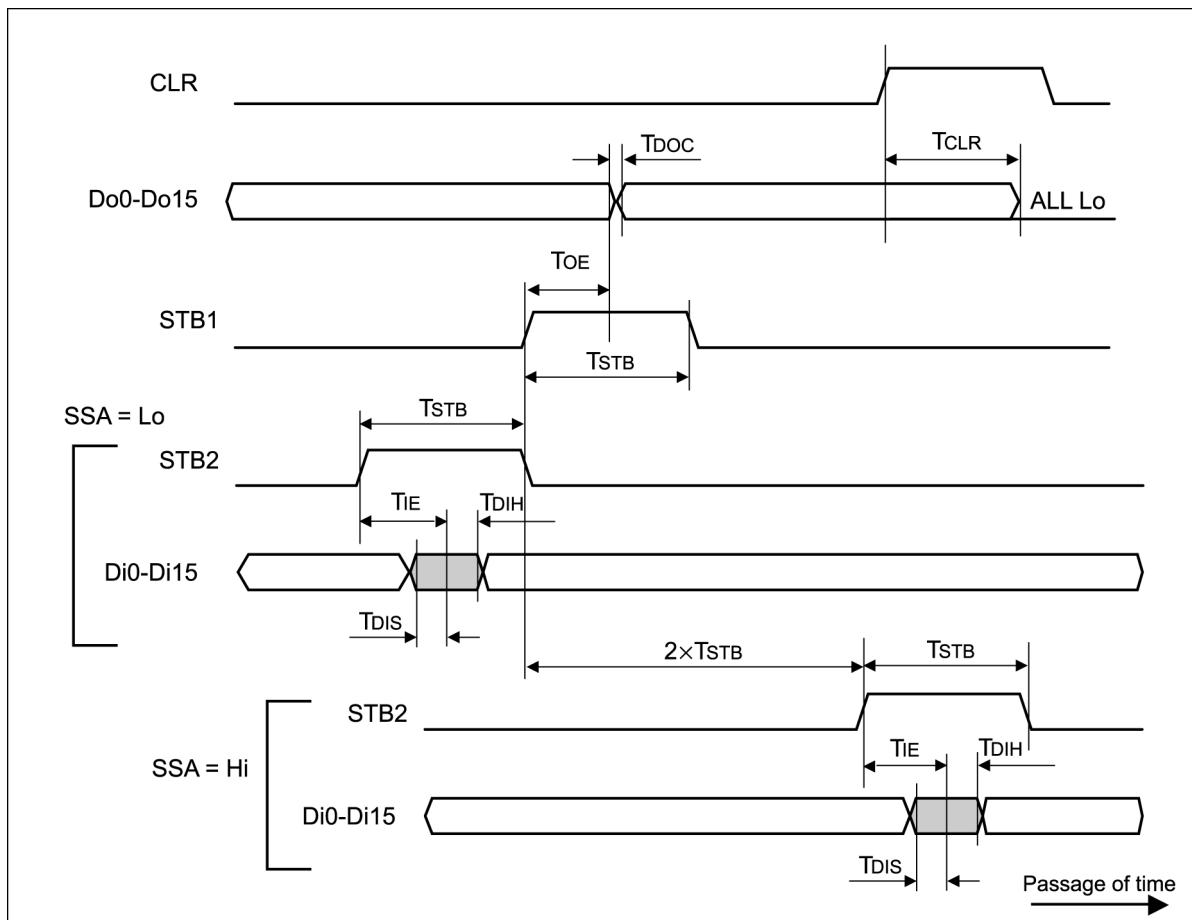
Symbol	Name	Min.	Typ.	Max.	Unit
T_{STB}	High-level width of strobe signal	$(2 \times T_{BPS})$ -5	$2 \times T_{BPS}$	$(2 \times T_{BPS})$ +5	ns
T_{OE}	Access time from STB1	$0.75 \times T_{BPS}$	T_{BPS}	$1.25 \times T_{BPS}$	ns
T_{DOC}	Do data transition time	0	---	20	ns
T_{IE}	Access time from STB2	$0.75 \times T_{BPS}$	T_{BPS}	$1.25 \times T_{BPS}$	ns
T_{DIS}	Di data setup	20	---	---	ns
T_{DIH}	Di data hold	0	---	---	ns
T_{CLR}	High-level sensing of CLR pin	T_{BPS}	---	$1.25 \times T_{BPS}$	ns

5.3 Package Dimensions

MKY37 (64-pin, TQFP)

INDEX MARK
Mirror finish

SEATING PLANE

Unit: mm
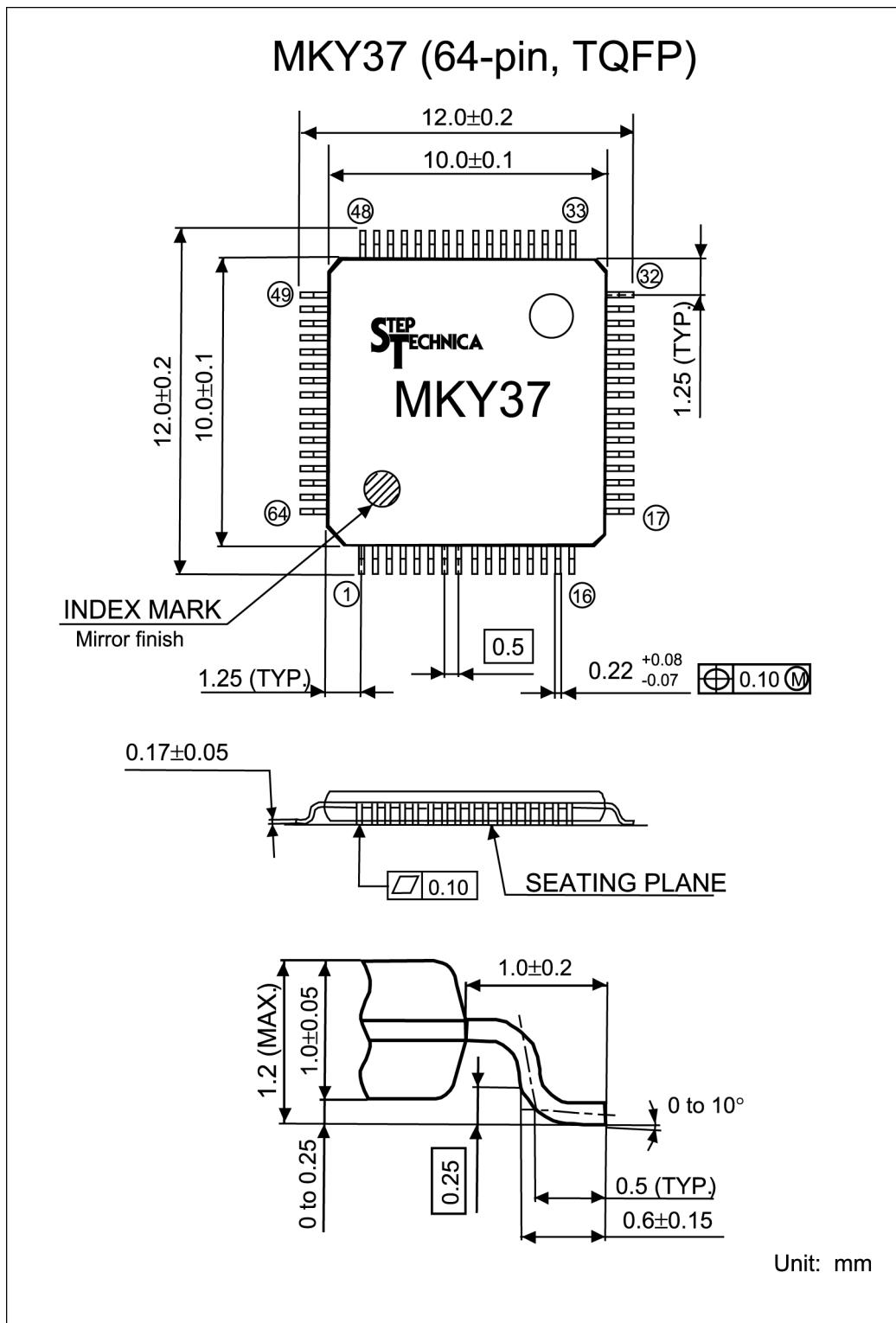
5.4 Recommended Soldering Conditions

Parameter	Symbol	Reflow	Manual soldering iron
Peak temperature (resin surface)	Tp	255°C max.	380°C max.
Peak temperature holding time	tp	10 s max.	5 s max.

Caution

(1) Product storage conditions: $T_A = 40°C$ max., RH = 85% for prevention of moisture absorption
(2) Manual soldering: Temperature of the tip of soldering iron 380°C, 5 s max.
     (Device lead temperature 260°C, 10 s max., package surface temperature 150°C max.)
(3) Reflow: Twice max.
(4) Flux: Non-chlorine flux (should be cleaned sufficiently)
(5) Ultrasonic cleaning: Depending on frequencies and circuit board shapes, ultrasonic cleaning may cause resonance, affecting lead strength

5.5 Recommended Reflow Conditions
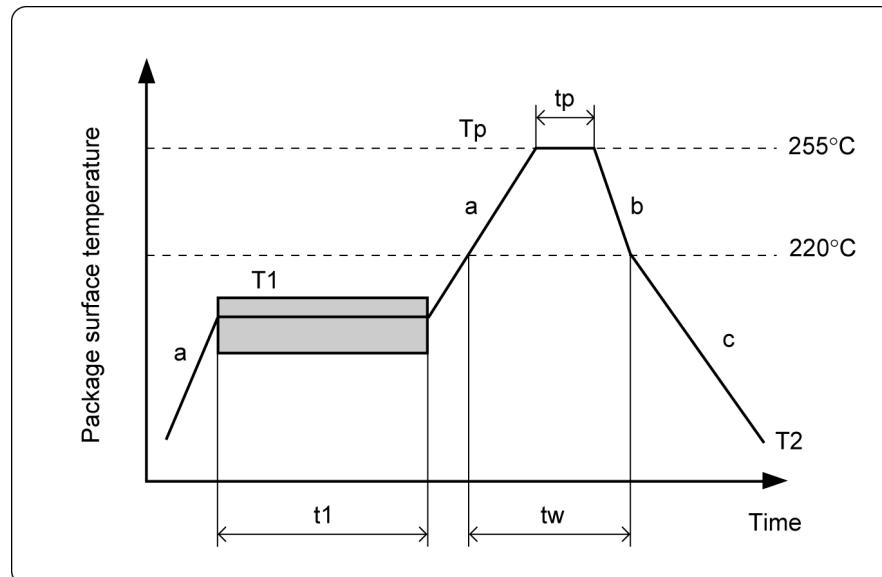
Parameter	Symbol	Value
Pre-heat (time)	t1	60 to 80/s
Pre-heat (temperature)	T1	150 to 190°C
Temperature rise rate	a	1 to 4°C/s
Peak condition (time)	tp	10 s max.
Peak condition (temperature)	Tp	255°C
Cooling rate	b	to 1.5°C/s
Cooling rate	c	to 0.5°C/s
High temperature area	tw	220°C, 60 s max.
Removal temperature	T2	≦ 100°C

Caution

The recommended conditions apply to hot-air reflow or infrared reflow. Temperature indicates resin surface temperature of the package.

# Appendix

Appendix

Appendix 1   Schematic Diagram of MKY37 Function

Strobe indicating when
to update 16-bit Do

40 — STB1

Do is updated at the pulse central
timing/Generated at every scan from center IC

| Previous Do data | New Do data |

Pulse width is $2 \times$ TBPS
(333 ns at 6 Mbps)

Strobe indicating when
to read 16-bit Di

41 — STB2

Di is read at the pulse central timing

| Di |

Pulse width is $2 \times$ TBPS
(333 ns at 6 Mbps)

Satellite IC
MKY37

Pin to set position
of STB2 to STB1

STB1

52 — SSA

Generated after STB2

Generated before STB2

Passage of time

Pin to set generation of STB2

53 — SSB

Every scan of STB2 generation

Handshaking with center IC

Pin to forcibly clear Do state (Low)

29 — CLR

Used to prevent system failure

Appendix 2   Model Diagram for Cascade Connection

Note: Fixing IA0 at High or Low prevents duplication of SA

App - 5

Hi-speed Link System
Satellite IC MKY37 User's Manual