Outline Description Sheets for G900x Series

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This pamphlet describes the basic terms and functions of the Motionnet G900x series device.

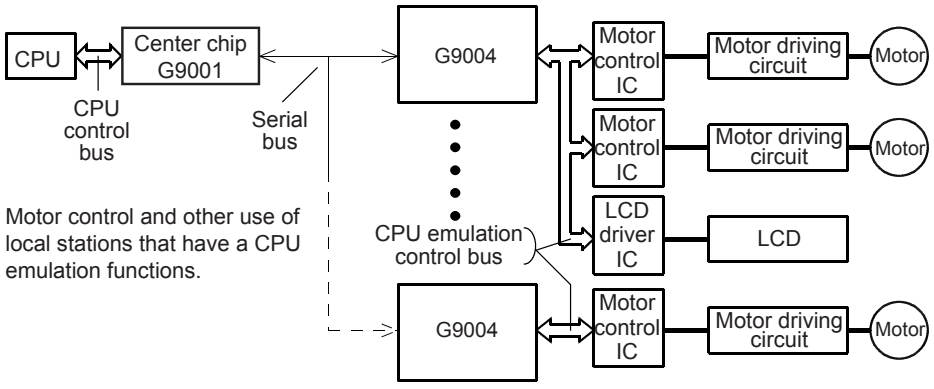
(1) Difference in communication methods between the G80xx (current models) and the G900x series.

Series	G900x	G80xx
Chips used	G9001, G9002, G9003, G9004	G8014, G8015
Communication data	I/O data + control data	I/O data
Communication speed	20 Mbps	2 Mbps
Communication distance	100 m	60 m or so. Up to 2 km possible as low speed.
Serial communication method	Half-duplex	Half-duplex
Transfer method	Cyclic + Transient transfer	Cyclic transfer
Communication connection style	Multi-drop	Multi-drop
Cyclic transfer cycle time (max.)	Max. 0.97 ms + [data communication] (64 x 32 I/O points = 2048 points)	Max. 0.888 ms (8 x 32 I/O points = 256 points)
Cycle time per point	0.47 µS	3.47 µS
Number of local devices	Max. 64	Max. 8
Transfer code	NRZ code	Manchester code
Local address setting	Automatic or manual	Manual (need to be contiguous addresses)

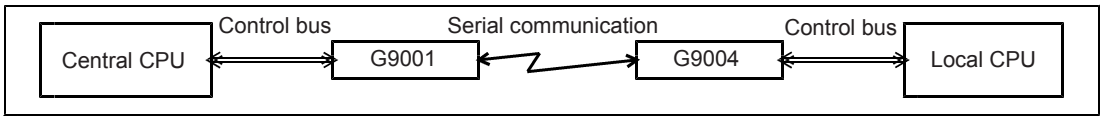
(2) CPU emulation device G9004

The G9004 has a function for creating dummy CPU bus operations. By connecting a CPU peripheral chip (such as a PCL) to the G9004, a center device can control CPU peripheral chips through communication (as master and slave stations).

In addition to the CPU emulation function, there is a message communication mode for communicating data between CPUs.



Block diagram for CPU emulation by a G9004



Block diagram of message communication using a G9004

(3) Difference in communication methods between the G900x series, DeviceNet, and a CC-Link

Series	G900x	DeviceNet	CC-Link
Supporting company	NPM	ODVA	CLPA (CC-Link Association)
Communication method	Master / slave method	CAN method	Master / slave method
Communication speed	20 Mbps	500 kbps	10 Mbps (ver.1)
Communication distance	50 m (20 Mbps), 100 m (10 Mbps)	100 m (500 kbps), 500 m (125 kbps)	100 m (10 Mbps), 1200 m (156 kbps)
Number of stations	64 (local devices)	64	64
Number of I/O points	2048	---	2048 (ver.1), 8192 (ver.2)
Cable	2 conductor (cat 5, 6)	5 conductor specialized cable	3 conductor specialized cable
Communication chip	G9000 series chip	Use a CAN chip with a special software application	Requires a specialized chip
System customization	Possible	Not possible	Not possible
System construction	Since the system is chip based, a, user can construct a specialized system with general purpose system possibilities.	Construct a system with a combination of general purpose products. Reduces system development time.	Construct a system with combination of general purpose products. Reduces system development time.

Advantages of the G900x series

1. Since the complete product is in the chip, the user can construct a specialized system any way he likes.
2. Some chips can generate pulse trains, and can control devices other than field bus dedicated drivers.
3. By using G9004, it is possible to save on wiring for general-purpose CPU control chips.
4. High-speed communication.
5. Can use ordinary LAN cables.

(4) Conditions necessary to reach 20 Mbps

Communication conditions	Cable	Termination resistance	Pulse transformer	I/F chip
20 Mbps, 100 m, 30 stations	CAT5 for LANs	100 ohms	1000 µHs	RS485 IC
20 Mbps, 50 m, 64 stations	CAT5 for LANs	100 ohms	1000 µHs	RS485 IC
10 Mbps, 100 m, 64 stations	CAT6 for LANs	100 ohms	1000 µHs	RS485 IC

Note: Normal communication definition: No error in 10 million communication cycles. CAT: Cable category. Pulse transformer model: DP101-102F (NPC), I/F chip: SN75LBC180AP (TI)

(5) Calculation method for the transfer time (The interval time in the formula includes the maximum processing time on the chip. The actual time will be less.)
The communication time can be calculated as shown below. However, the communication time will vary with the occurrence of errors and other factors.

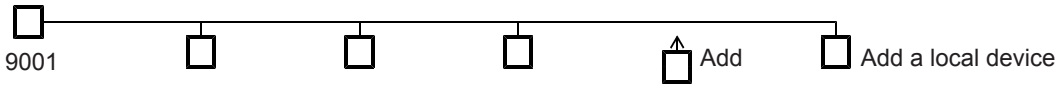
1. Communication time for one local device during I/O communication: 15.1 µS fixed [x number of local devices]
2. One communication cycle during data communication: Sending time + Response time + 7.4 (interval time) µs
   Sending time: Number of bytes sent x 0.6 + 3.25 µs
   Response time (with data): Number of bytes sent x 0.6 + 5.65 µs
   Response time (without data): 5.05 µs
3. Communication time of broadcast communication: 12.15 µs fixed
4. Communication time for system communication: 15.1 µs x 64 local device = 996.4 µs fixed

Example 1: Connect 34 local devices and perform cyclic transfer I/O communication. The cycle time will be: 34 x 15.1 µs = 513.4 µs

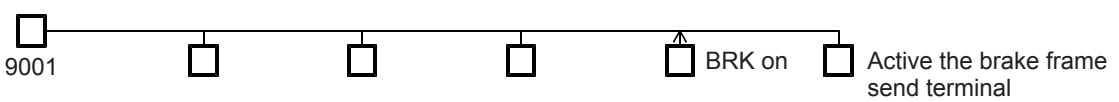
Example 2: Connect 34 local devices and perform the following data communication four times: send 2 bytes and receive 6 bytes during I/O communication. The cycle time will be as follows (using G9003 and 2 bytes of register commands + 6 bytes of data):
Cyclic transfer I/O communication; 513.4 µS
Data communication: (2 bytes x 0.6 + 3.25) + (6 bytes x 0.6 + 5.65) + 7.4 = 21.1 µs
21.1 µs x 4 times = 84.4 µS
Total: 513.4 + 84.4 = 597.8 µS

(6) Method for adding a local device
When a local device is connected with a pulse transformer the primary side and secondary side are insulated and therefore the device can be added during communication. (Be careful not to place an abnormal voltage on the communication line.)

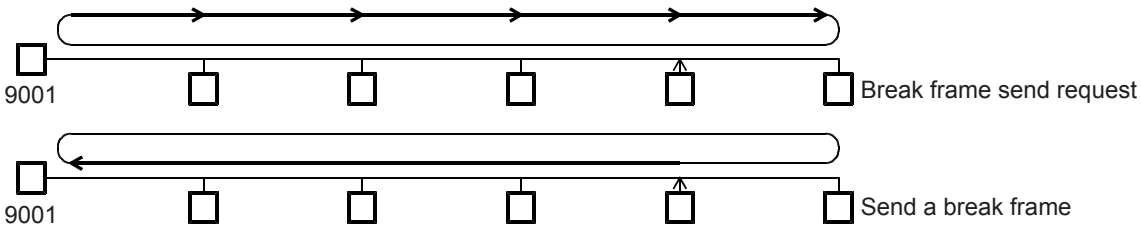
1. Add a local device to the communication line.
   When connected, the communication signal may be disturbed, and the current communication may fail. However, if the communication fails the system will retry the communication and there should be no problem.



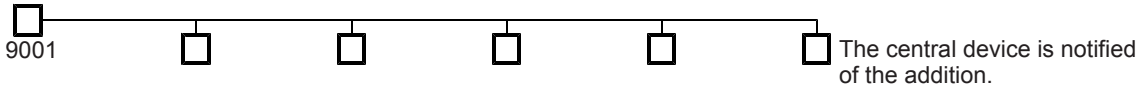
2. After a device is added, active the BRK terminal (break frame send request) on the local device. By doing this, the local device will respond with a break signal to notify the central device that something has been added when it receives a break frame request.



3. The central device periodically checks whether there is a local device that wants to be added. The central device sends a break frame send request to ask any new local devices to respond with a break frame (a special pattern of data to notify the central device of an addition). If a device has just been added, it will return a break frame.

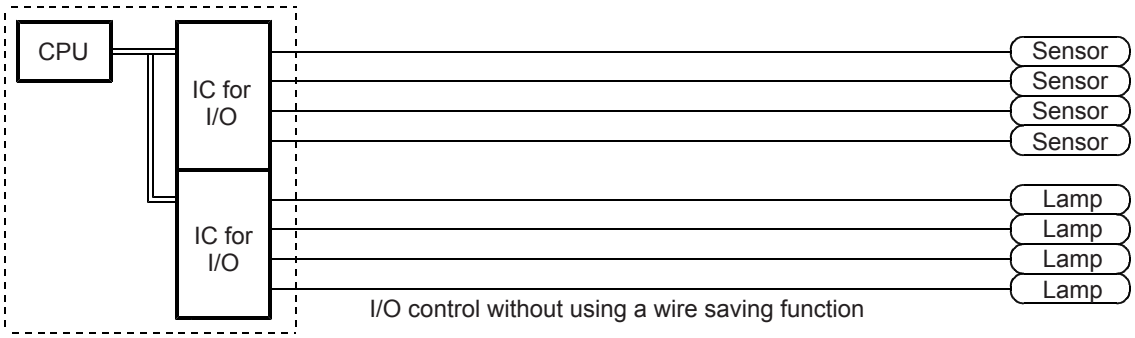


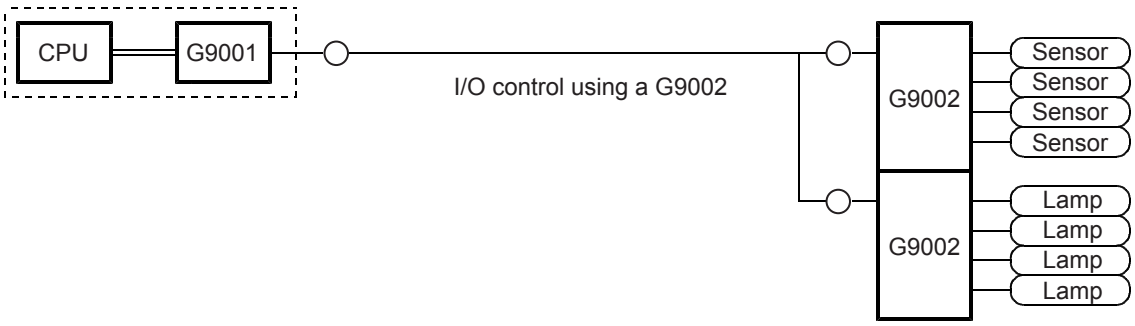
4. When a local device returns a break frame, the central device program must search for the new local device and add it. This is how the system can add a local device.



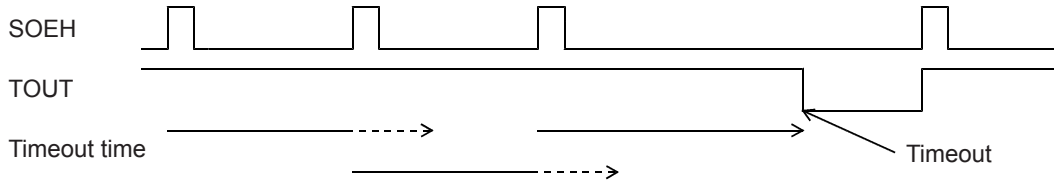
(7) An example using the G9001

The G9001 is a device for controlling I/O (input and output signals).
For example, suppose that a system has 32 lamps and 96 sensors, and you want to control them using a CPU. It is not possible to connect 32 + 96 signals to the CPU board. Without using some kind of wire saving aid, you would have to use ICs to extend the number of I/O ports. However, you also have to run wires over a long distance.
What you can do instead is to use one G9001 (central device) and four G9002s (I/O). Use one G9002 for output (32 output points) and three G9002s for input (32 input points x 3). You just connect the reduced number of lines between the CPU, the G9001 and the four G9002 chips. Then, connect the sensors and indicators between the four G9004s with short lengths of wire. The devices you connect can be valves, relays, solenoids, lamps, sensors, etc.





(8) What is a watchdog timer? When too much time passes, both the I/O device and PCL device need to be reset to resume operation. How can this be done?
A watchdog timer is a timer used to monitor the status of a device or system for a certain period, to make sure to a device is operating normally.
With the G9002, 9003, and 9004, if they communicate normally, the watchdog timers are reset by SOEH signals. If an SOEH signal is output regularly, the TOUT signal is kept OFF. However, if no SOEH signal is output after a certain time, a timeout occurs and the TOUT signal goes ON.
Therefore, a timeout occurs when the communication stops.



For example, suppose that the communication line for a PCL device (G9003) is disconnected. In order for a device to operate and stop a motor using communication lines, the communication line must remain connected during operation. To deal with the possibility of a disconnection, a timer is used to stop the motor if it times out. In other words, the motor will stop when the communication line is disconnected.
In another example, let us consider a system in which a G9002 I/O device controls a valve. The system will be designed to close the valve when the communication line is disconnected for a specified period. As above, you can select to stop the motor and reset the terminal (OFF) when the watchdog timer times out.

(9) What are cyclic transfer and transient transfer?
Cyclic transfer is a method for communicating with all the connected local devices one at a time in a specified order. Since the target device for communication is changed in cyclic fashion, this is called cyclic transfer of data (I/O communication).
Transient transfer is a data communication method that interrupts the cyclic transfer of data when needed.
The G9000 series can execute a transient transfer only one time between the communication with one local device and the next local device. Namely, if there are 64 local devices, you can use the transient transfer approach a maximum of 64 times within one cycle.
Meaning of "Cyclic": Repeated over time
Meaning of "Transient": Short, unscheduled event

There are two types of local devices: I/O device (G9002) that uses cyclic transfer, and data device (G9003, G9004) that uses both the cyclic transfer and transient transfer.

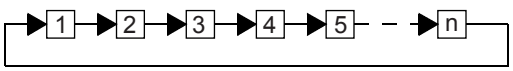
(10) What communication functions have been added to the basic T-NET approach?
NPM's T-NET, used by our G80xx series, only uses cyclic transfer for communication. The T-NET version of cyclic transfer communication has a fixed communication data length of 1 byte (8 bits) per local device. The G8014 can transmit 1 to 4 bytes (32 bits) to a single device (using 1 to 4 cyclic transfers to do this).
In the G900x series version of cyclic transfer, the communication data length is fixed at 4 bytes (32 bits). Four bytes are sent in one cyclic transfer to one device and you cannot send less than four bytes.

In addition, if you want to send more data to the same local device after sending 4 bytes of data using cyclic transfer, you have to wait one full cyclic transfer cycle.

Cyclic communication (for communication of I/O data)

[Each cyclic communication is limited to 32 bits]
[To communicate with the same device, you have to wait for another cycle]

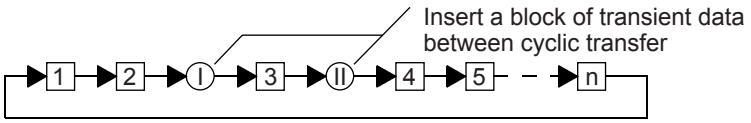
To communicate with the PCL or with other devices, we have to send several sets of 4 bytes (32 bits) or more (256 bytes etc.). It is difficult to set data to these devices in only one cyclic transfer.
In order to solve this problem, a data communication function (transient data transfer) has been added to the G900x. Although you still use cyclic transfer for one session, this data communication function can communicate a maximum of 256 bytes of data in one cyclic transfer. In addition, if 32 stations are connected, the system will communicate data 32 times per one cycle.
However, the time taken by transient data communication will increase the cycle time (cyclic transfer + transient transfer) and the total cyclic time will vary. For this reason, systems must have a short cycle time may need to have special independent lines for transient transfers.
However, systems that do not perform data communication can achieve high-speed communication. Systems that allow small variations in the cycle time can be controlled with one line using this method.



[Without transient transfer]

□: Cyclic transfer

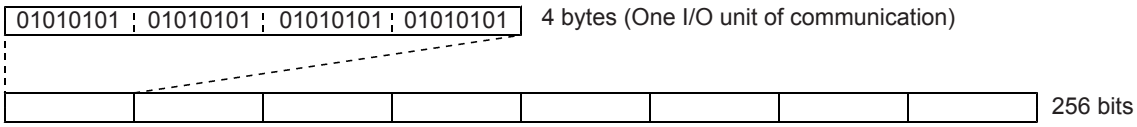
◯: Transient transfer



[Cyclic transfer that includes two transient transfers]

G9001: Data communication and I/O communication (cyclic transfer + transient transfer)
G9002: I/O communication only (only uses cyclic transfer)
G9003: Data communication and I/O communication (used to monitor chip status etc.)
G9004: Data communication and I/O communication (used to monitor chip status etc.)

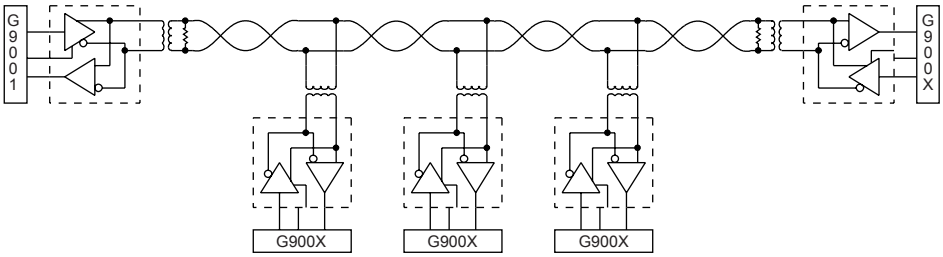
(11) What does a data transfer to one device look like? How about with 256 bits of data?



Up to 64x length data can be sent/received at one time.

(12) What is a multi-drop connection system?
This system lets you attach lots of devices to a single line.

[Multi-drop block diagram using the G9000 series]



(13) What are the differences between RS-232C and RS-485?

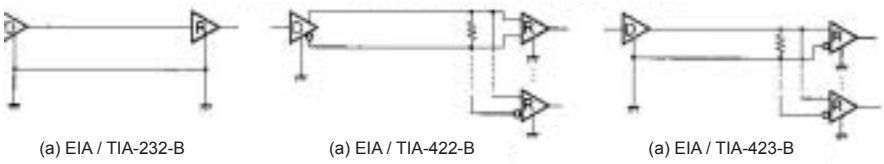
These are abbreviations for "Recommended Standard 232C" and "Recommended Standard 485." These were created by EIA (Electronic Industries Association), and are formally referred to as TIA/EIA-232-E-91 and TIA/EIA-485. TIA is an abbreviation of "Telecommunications Industry Association."

The RS-232 standard includes communication protocol. The RS-485 is a standard for electrical characteristics, which are mainly concerned with driver and receiver characteristics. An electrical circuit used to output signals is referred to as a driver. A circuit used to receive signals is referred to as a receiver. An electrical circuit with both a driver and a receiver is referred to as a transceiver. All of these circuits are available as ICs for handling serial signals.

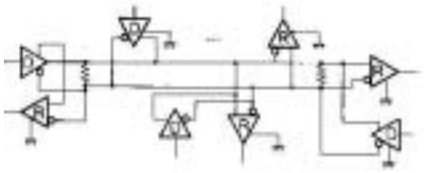
RS-485 devices have sufficient energy to reflect a signal that reaches the end of the electrical circuit. In order to prevent interference from the reflected signals, resistors are installed at the physical ends of the circuit. They are called terminating resistors.

Standard	Outline	Driver/receiver	Speed
RS-232C	Standards for communications protocol, signal lines, and electrical characteristics	Unbalanced type (single ended)	20 Kbps
RS-422	Standards for electrical characteristics	Differential type	10 Mbps
RS-485	Standards for electrical characteristics	Differential type	10 Mbps

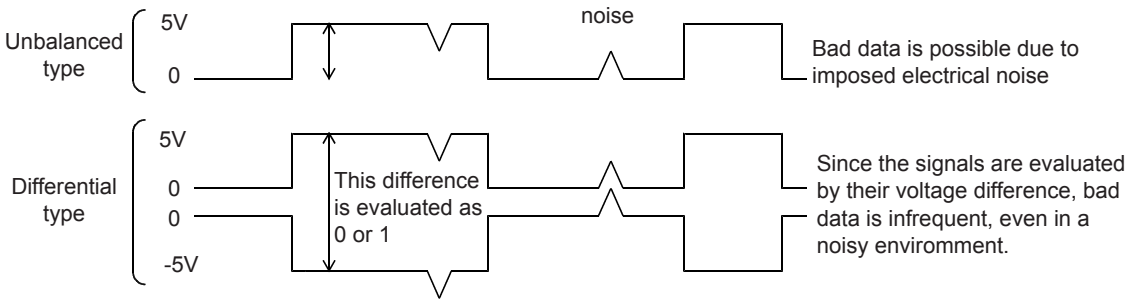
<Figure 1> Driver and receiver circuits for each serial interface standard



(a) EIA / TIA-232-B (a) EIA / TIA-422-B (a) EIA / TIA-423-B



(d) EIA / TIA-485



(14) What is NRZ code?

NRZ means Non-Return to Zero.

This system of coding is used in the G900x series. It is method for coding the transmitted data according to the current signal status of a communication circuit.

This method reduces the pulse length and signal harmonics of the communication so that a small transfer bandwidth can be used.

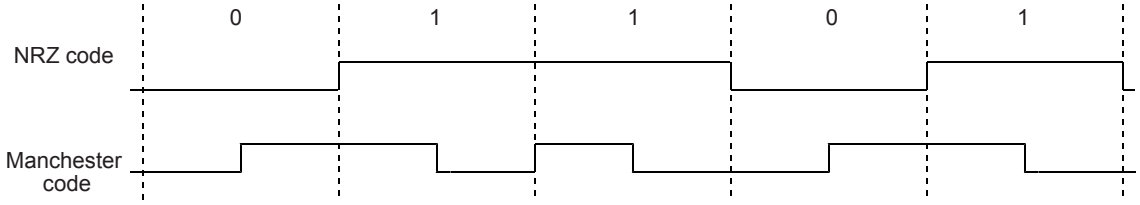
The G900x series have additional circuits to avoid using NRZ coding, to allow pulse transformers to be used. (When using a pulse transformer, the signals must not vary in length more than a certain amount.)

Manchester

This is another coding system and it is used by the G80xx series. This is a data modulation method in which the first half of the bit value is the same as the bit data, and it is reversed in the middle of the bit transmission. There is also a variation of this system in which the first half is reversed from the bit value.

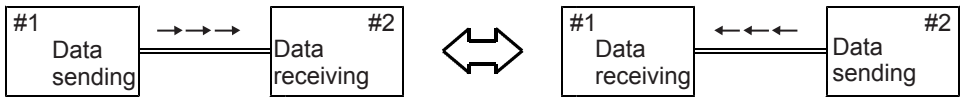
With this system, neither a 0 or a 1 is sent continuously for a long time The data received flips the signals every half bit, so that the system will not misread continuous signals of 1 as strings of 0.

This is also referred to bi-phase encoding.



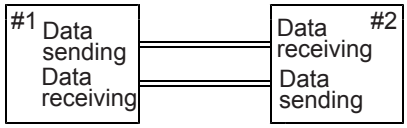
(15) What is half-duplex communication?

Half-duplex is a communication method for transmitting data from one side and then the other, alternately. It supports bi-directional communication. However, this system does not allow both sides to send data simultaneously. Using a transceiver, a signal line can be used to send and receive.



Full-duplex

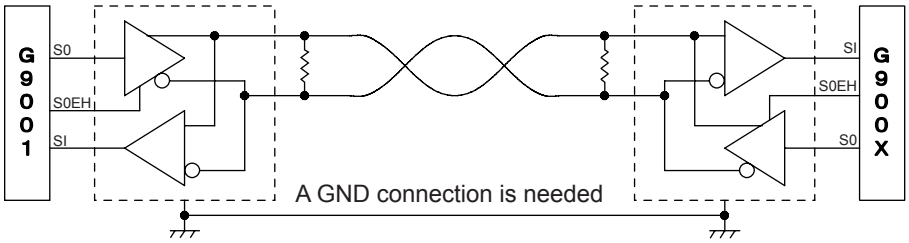
This is a communication method that support both sending and receiving independently. This system allows data to be sent by both sides simultaneously. Since two communication lines are needed, the cost will be higher, but the transmission efficiency will be improved.



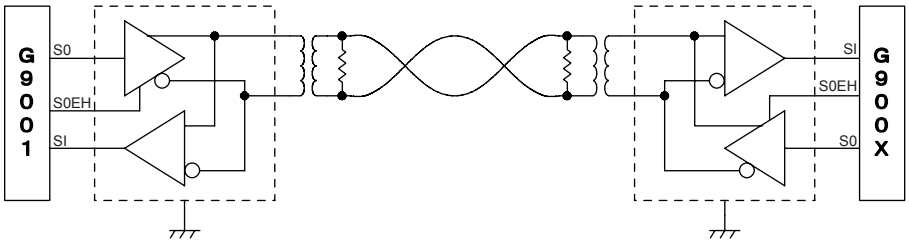
(16) What is a pulse transformer?

This is a transformer that is used exclusively to handle pulsed signals. The primary and secondary sides of the transformer are isolated, which means that the GND on different equipment can be separate. (If the GND line is too long, noise may be picked up.)
When you want to use pulsed signals for communication, they should be repeated ON/OFF (1/0) at a certain frequency.
With the G series, pulse transformers are used in combination with RS-485 driver/receive as follows:

[Direct connection of RS485 transceivers]



[Connecting RS485 transceivers through pulse transformers]



(17) What is "frame unit"?

In serial communication, parallel data are converted into a serial string of bits and then sent. The term frame refers to a defined block of data which is sent at one time in a serial string. The block may also be referred to as a packet.
Serial communication of a frame in the G900x series consists of the followings:

Start bit	Address	Data [Control commands and data]	Check code	Stop bit

<Start bit>
When sending data in a serial formal, this bit identifies the start of the data.
The side receiving the data synchronizes its reception with this bit.
<Address>
Identifies which terminal station on the serial bus is being sent the data.
Normally, duplicates of the same address are not allowed on the same network.
<Data>
The data sent to a target station.
When you need to control a local terminal, control commands are included in the data.
<Check code>
These bits are used to check whether the data was received correctly or not.
After the check code has been verified, the side receiving the data passes it along to the device.
<Stop bit>
This bit indicates the end of the data.

In order to synchronize a communication route, a header of repeated 0s and 1s is added in front of a frame.

(18) What is an address map? What is a 512 bytes area?

	Address				Data (byte)							
	A2	A1	A0		D7	D6	D5	D4	D3	D2	D1	D0
7	1	1	1	→								
6	1	1	0	→								
5	1	0	1	→								
4	1	0	0	→								
3	0	1	1	→								
2	0	1	0	→								
1	0	0	1	→								
0	0	0	0	→								

When a CPU addresses a PCL or memory, it changes the address signal status in order to select the data it wants to access.
In the table on the left, the CPU can select an address using three address lines (A0, A1, and A2), which means that the CPU can access can access 2^3 addresses (2^3 is 8 in decimal notation). That represents a data area that contains 8 bytes. The G9001 has 9 address lines (A0 to A8) so the area it can access contains 512 bytes (2^9 bytes).

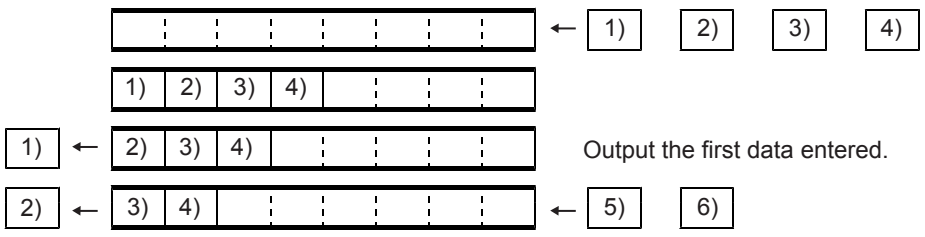
An address map is a way of showing the details of a specific address scheme.
In the example below, the address map is designed to show what happens when writing to a PCL6025. Tables or figures that show the relationship between an address and the data being accessed are referred to as an address map.

A1 to A2	Processing details
00	Write an axis selection and a control command
01	Change the general-purpose output port status (valid only for bits specified as outputs)
10	Write to an input/output buffer (bit 0 to 15)
11	Write to an input/output buffer (bit 16 to 31)

(19) What is FIFO?

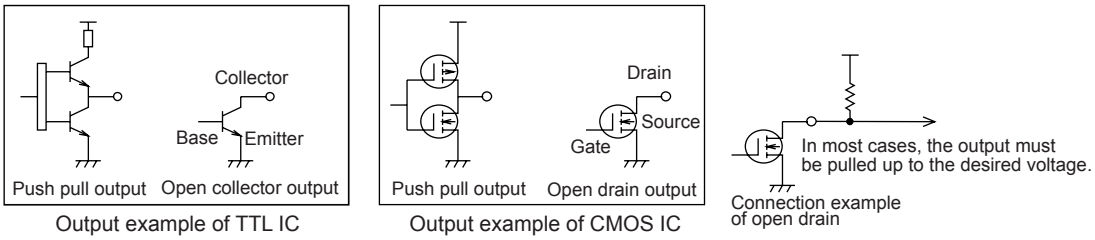
FIFO is an abbreviation of First In First Out. It is a memory storage method.
The first data input in this memory is the first data that is output. Data can be added to this type of memory until it is full. The output side can retrieve data for output until the memory is empty. The data input and output timing can be adjusted.
In the G900x series, this memory is used to store the data for data communication.

[FIFO image]



(20) What is an open drain output and an I/O buffer with a failsafe?

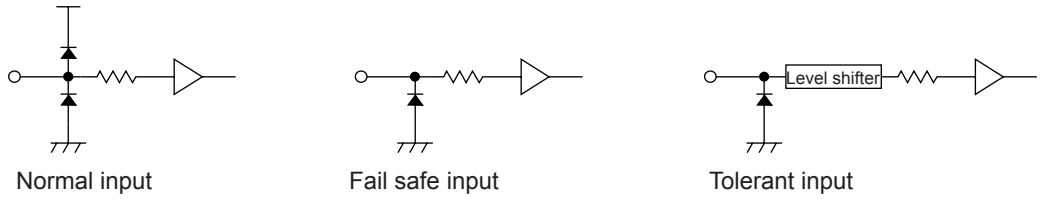
Open drain output



Open drain output refers to a buffered output that only drains current (LOW). When using a TTL IC this arrangement is called an open collector circuit. When using a CMOS IC, it is called an open drain circuit. Since the G9000 series uses CMOS construction, they are called open drain terminals.

A normal IC circuit has a push-pull type output, and the signals will be LOW or HIGH. However, an open drain circuit is either ON or OFF (compared with 0V), so the signals LOW or floating. To make this kind of terminal HIGH, you have to pull it up using a resistor.

Input buffer with fail safe



A failsafe input refers to a buffered input without a diode on the power supply side. Normally this circuit is used to push/pull a live conductor (like pulling out a card while the power to the computer is ON). The G9001 uses an input buffer with a failsafe construction in order to allow connection of a 5 V signal (the power supply in the G9001 is only 3.3 V). In order to receive a 5 V signal when using 3.3 V signal levels, the signal input sensitivity must be deteriorated, as compared with a tolerant input design, which is described later.

A tolerant input refers to level shifter which is added to a failsafe input. The G9002 and G9003 use tolerant inputs in order to allow connection to 5 V signals.

Using these input buffers, the G90oo series can connect to 5 V signal, even though they are a 3.3 V power supply.

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