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IGBT Inverter, IGBT Converter

TMdrive-30, TMdrive-P30

Instruction Manual

Oct, 2004

TOSHIBA MITSUBISHI-ELECTRIC
INDUSTRIAL SYSTEMS CORPORATION

TM_F5000B

Maintenance, inspection, and adjustment of this equipment require specialized knowledge.

Read this manual completely and carefully before using this equipment.

Personnel who use this equipment should undergo specialized training provided by our TMEIC on a for-fee basis.

Contact your TMEIC representative for details on training courses.

Contents

1 Usage Notes

This equipment includes high-voltage components. To prevent electric shock, burns, or other injuries when using this equipment, and to maintain its performance, be sure to read this manual before using this equipment. Also, observe all warning labels attached to the equipment.

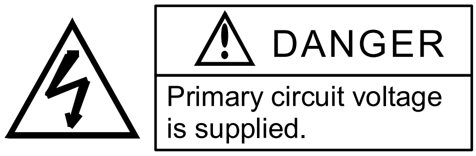
The ⚠ and ⚠ marks have the following meanings:

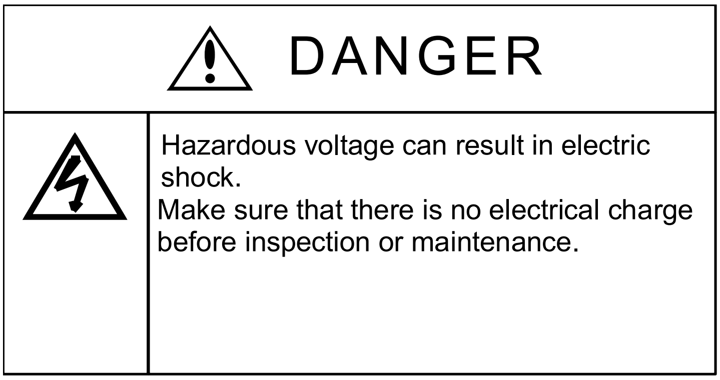
⚠: Electric shock warning	⚠: Warning for safe work

■ Danger (Red Label)

Failure to avoid locations or actions marked in this manner may lead to serious injury or death.

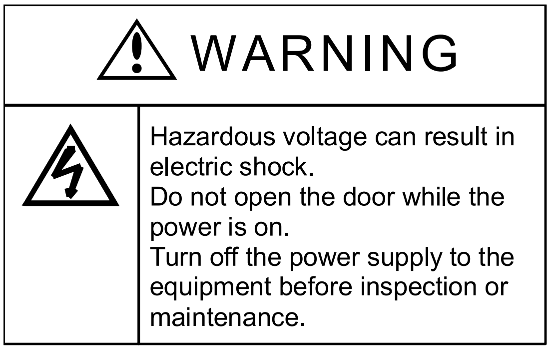
[Warning Label Examples]

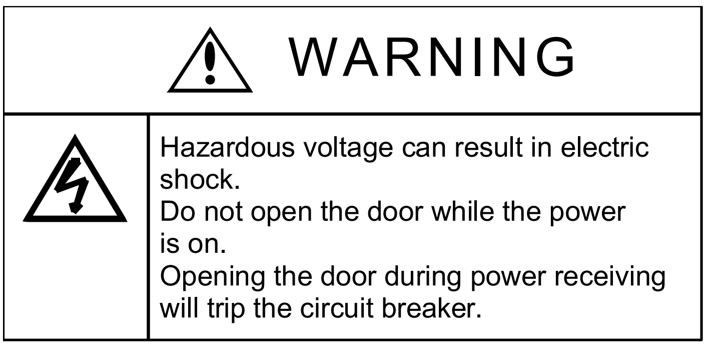




■ Warning (Orange Label)

Failure to avoid locations or actions marked in this manner may lead to injury, albeit of a somewhat lesser severity. Failure to follow these directions may also lead to property loss, such as damage to the equipment or components, or to fires.





■ Notice (Green Label)

These labels provide advice that can assure safe operation, can prevent errors and performance degradation in the equipment, and can be useful in preventing breakdowns.

[Warning Label Examples]

!	NOTICE When operating or adjusting the equipment and during maintenance/ inspections, be sure to observe the precautions noted in the User's Manual.

■ Others (White Labels)

These labels present items related to maintaining the performance of the equipment.

The following are guidelines for the replacement of parts.

PARTS	GUIDELINES FOR REPLACEMENT
COOLING FAN	3 YEARS
ELECTROLYTIC CAPACITOR	7 YEARS
POWER SUPPLY UNIT	7 YEARS
FUSE	7 YEARS

1.1 To Prevent Electric Shocks!

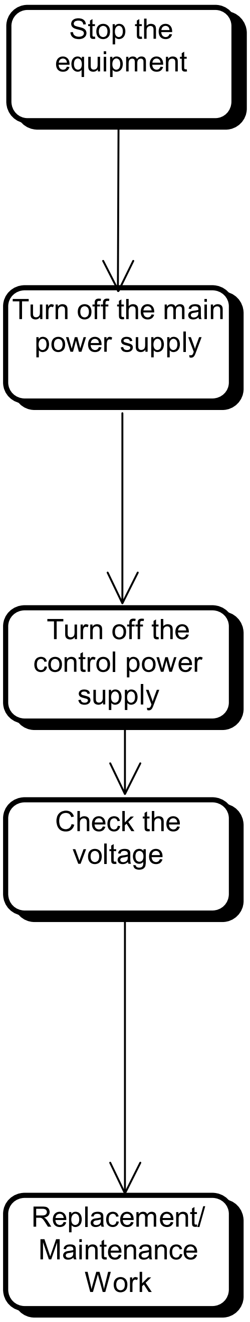
The inverter (TMdrive-30) has 1250 V ac or more, 1800 V dc or more and 200 V ac or 220/230 V ac circuits, and the converter (TMdrive-P30) has 1100 V ac or more, 1800 V dc or more and 200 V ac or 220/230 V ac circuits, which are extremely dangerous. Do not remove the protective covers designed for shock prevention at any time other than inspection and maintenance.

Do not touch the inside panel or parts of the equipment while the power is being applied or the motor is running.

Do not touch internal parts with wet hands.

1.2 TMdrive-30 Inspection and Maintenance and Recovery Procedures

1.2.1 Inspection and Maintenance Procedure (Power-off Procedure)



(1) Stop the load equipment, and verify that all electrically powered equipment has stopped completely.

(2) Turn on the operation panel interlock switch by pressing it. Prohibit operation of the inverter on the hardware (safety or emergency stop switch, etc).

(Note) When a common DC power supply is used, make sure that all devices connected to the DC power supply have been stopped.

(3) Before starting the inspection and maintenance of the inverter, stop the common power supply panel supplies to the equipment and move the circuit breaker to the safety area to prevent it from being turned on accidentally (safety maintenance in twice).

(4) Wait for at least five minutes.

(5) Make sure that the charge lamp on the inverter panel is off.

(6) Turn off the control power supply MCCB ("CONTROL").

(7) Unlock the door padlock.

(8) Remove the screws (two places) on the front door of the inverter panel and open the door with the door handle.

(9) Use a voltage checker and the like to check that the main circuit and the control circuit are already discharged.

(10) Measure the voltage between check pins HIGH-LOW on the GDM board to check the main circuit voltage is at a safe level.

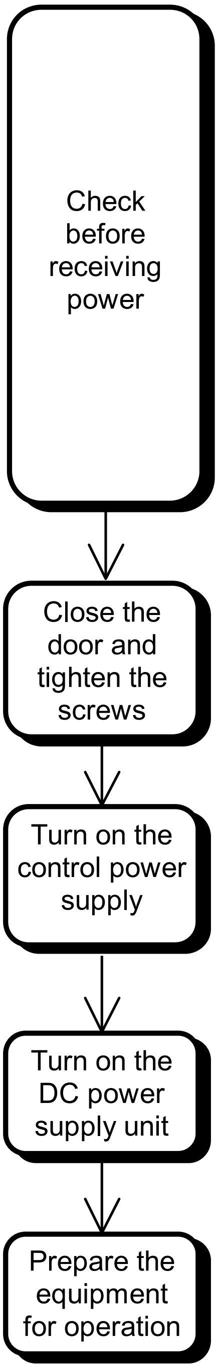
(11) Measure the voltage between check pins P-CTR-OV-CTR on the GDM board to check the control power supply voltage is at a safe level.

(12) Perform safety measures (grounding, etc) according to need

(13) When the unit (IPU*) is replaced, see the Unit Replacement Manual (document No. 6F3A4795).

* IPU: An abbreviation for IGBT Power Unit

1.2.2 Recovery Procedure (Power-on Procedure)



(1) Before turn on the power supply, check the DC power supply is off.

(2) Check the recovery status of the sections that were disconnected for inspection and maintenance and the replaced parts (connector insertion status, conductor tightening status, etc.)

(3) Release of the safety measures (grounding, etc).

(4) Check that operations of all supplied inverters are prohibited on the hardware (safety or emergency stop switch, etc).

(5) Check that front doors of all supplied inverter panels are closed and the screws (two places) are tightened.

(6) Close the front door of the inverter panel and tighten the screws (two places).

(7) Lock the door padlock.

(8) Turn on the control power supply MCCB ("CONTROL").
Note: Check that there is no error detected.

(9) Check that Fault or Alarm isn't displayed on the operation panel on the automatic control panel. If Fault or Alarm is displayed, check the fault message and then recovery it.

(10) Turn on the DC power supply unit main power.

(Note) When a common DC power supply is used, check that all devices connected to the DC power supply are ready to receive power.

(11) Check the safety of the system and release of the operation prohibited on the hardware (safety or emergency stop switch, etc).

1.3 TMdrive-P30 Inspection and Maintenance and Recovery Procedures

1.3.1 Inspection and Maintenance Procedure (Power-off Procedure)

Stop the equipment

(1) Check that all supplied inverters have stopped completely then turn off the "AC MAIN CIRCUIT BREAKER" switch on the automatic control panel to stop the equipment and to turn off move the circuit breaker. In addition, move the circuit breaker to the safety area to prevent it from being turned on accidentally (safety maintenance in twice).

(2) Check that the "ON" LED is off (unlit) and the "OFF" LED is on (lit) on the automatic control panel.

(3) Prohibit operation of the converter on the hardware (safety or emergency stop switch, etc).

↓

Turn off the main power supply

(4) Wait for at least five minutes.

(5) Make sure that the charge lamp on the inverter panel is off.

↓

Turn off the control power supply

(6) <u>Turn off</u> the control power supply MCCB ("CONTROL"). The “OFF” LED on the automatic control panel turns off (unlit).

↓

Check the voltage

(7) Unlock the door padlock.

(8) Remove the screws (two places) on the front door of the converter panel and open the door with the door handle.

(9) Use a voltage checker and the like to check that the main circuit and the control circuit are already discharged.

(10) <u>Turn off</u> the control power supply MCCB ("CONTROL"). The “OFF” LED on the automatic control panel turns off (unlit)

(11) Measure the voltage between check pins HIGH-LOW on the GDM board to check "the main circuit voltage is at a safe level.

↓

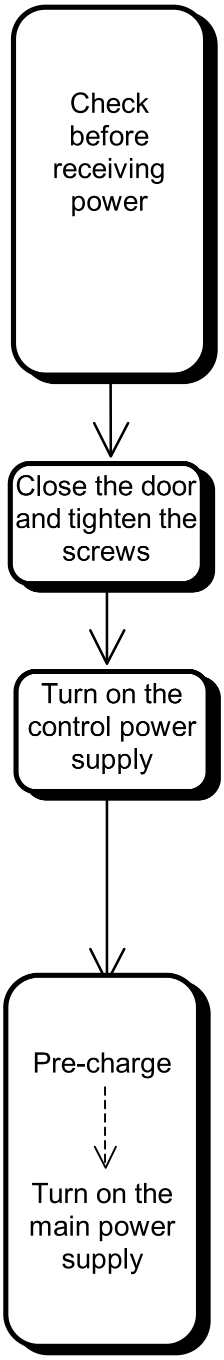
Replacement/ Maintenance Work

(12) Perform safety measures (grounding, etc) according to need

(13) When the unit (IPU*) is replaced, see the Unit Replacement Manual (document No. 6F3A4795).

* IPU: An abbreviation for IGBT Power Unit

1.3.2 Recovery Procedure (Power-on Procedure)



(1) Before turn on the power supply, check the DC power supply is off.

(2) Check the recovery status of the sections that were disconnected for inspection and maintenance and the replaced parts (connector insertion status, conductor tightening status, etc.)

(3) Release of the safety measures (grounding, etc).

(4) Check that operations of all supplied inverters are prohibited on the hardware (safety or emergency stop switch, etc).

(5) Check that front doors of all supplied inverter panels are closed and the screws (two places) are tightened.

(6) Close the front door of the converter panel and tighten the screws (two places).
(7) Lock the door padlock.

(8) <u>Turn on</u> the control power supply MCCB(“CONTROL”).

The “OFF” LED on the automatic control panel turns off (lit).

(Note) Check that there is no error detected.

(9) Check that Fault or Alarm isn’t displayed on the operation panel on the automatic control panel. If Fault or Alarm is displayed, check the fault message and then recovery it.

(10) Check the safety of the system and release of the operation prohibited on the hardware (safety or emergency stop switch, etc).

(11) When the "AC MAIN CIRCUIT BREAKER" switch on the automatic control panel is turned on, the pre-charge automatically starts. (If pre-charge does not start, examine the items for which the electrical condition (UV) is not satisfied and satisfy the condition.) During pre-charge, the "ON" LED on the automatic control board blinks.

(12) The pre-charge completes in about 10 seconds. Upon completion of pre-charge, the main power supply is turned on automatically. When the main power supply is turned on, the "ON" LED on the automatic control board turns on (lit).

(This procedure is applicable only when the circuit breaker automatic interface is provided (See Section 5.3). The circuit breaker can be operated in one of the following three ways; from the main automatic control panel, from the circuit breaker panel, or remotely.)

1.4 Operation

Be sure to strictly adhere to the power-on procedure and power-off procedure (See Sections 1.2 and1.3). Otherwise unnecessary stress will be incurred.

PROHIBITION	
⚠	While the equipment is in operation and the motor is running, do not turn off the main circuit power supply or control power supply under any circumstances. Do not disconnect any unit during operation.

1.4.1 Normal operation of TMdrive-30

Normal operation through interface should be performed by the following procedure after confirming that the necessary interface signals are securely connected.

(1) Set the speed command signal to the lowest state.

(2) Turn on the IL (Interlock) input signal and EXT (operation command) input signal.

(3) As the speed command signal is increased gradually, the motor rotates at a rate proportional to the speed command signal. If the motor does not rotate normally, check the wiring of the main circuit inverter output circuit and the speed detector again.
As for the rotational direction of the motor, the forward rotational direction differs depending on the machine to drive. See the schematic diagram. To reverse the rotational direction, set the polarity of the speed reference to negative. To reverse the rotational direction (forward rotation) by the positive speed reference, reverse the polarity of the setting value of $CS_MOTOR_RPM, turn off the control power supply once then turn it on again. Do not change the wiring of the resolver and the main circuit.

(4) If you turn off the EXT signal during rotation, the motor will slow down and stop.

1.4.2 Normal operation of TMdrive-P30

Normal operation through interface should be performed by the following procedure after checking that the necessary interface signals are securely connected.

(1) Set the given voltage reference.

(2) Turn on the IL (Interlock) input signal and EXT (operation command) input signal.

(3) When the main power supply is turned on following the procedure in Section1.3.2, the operation ready (READY) condition is satisfied and the operation starts.

(4) If you turn off the EXT signal during operation, the converter stops.

1.4.3 Test operation

Test operation can be done using the maintenance tool.
Before performing test operation, check the following items:

(1) Check that the necessary signals are securely connected.

(2) Check that operation on the main unit side is off and the equipment is completely stopped.

(3) Contact the person in charge of field operations and obtain permission for individual operations.

After checking the above items, perform test operation.

The test mode shown in Table 1.4.1 is available for test operation.

Table 1.4.1 Test Mode

Test mode No.	Name	Purpose
TEST-22	Speed step response	To check the response of speed control by stepping up speed reference.
TEST-25	Load response	To check the response of speed control by stepping up torque reference.
TEST-26	Flux current step	To check the response of current control by stepping up flux current reference.
TEST-29	Acceleration/Deceleration response	To check the acceleration / deceleration response in internal acceleration / deceleration rate by stepping up speed reference input.

In order to use the test mode, operate the drive in the following procedure. Refer to the operation manual of the support tool for the usage of a step response function.

(1) Check the operation of the drive equipment is off. The drive equipment cannot enter the test mode while that is in operation.
(2) Select a required test mode by using step response function of the support tool. When the test mode is chosen, the drive equipment enters the test mode (panel ready lump is blinking).
Set step value and step time in step response function.
(3) Operate the drive equipment at the motor speed which the test is performed (TEST-22,25).
Turn on the flux current by inputting operation command (EXT) etc (TEST-26).
Stand-by the motor acceleration by inputting operation command (EXT) (TEST-29).
(4) Push the step start button of step response function to perform the step response.
(5) After step response is finished, obtained data is displayed on the support tool.
Repetitive step response can be performed.
(6) Push test finish button of step response function to finish the test mode.

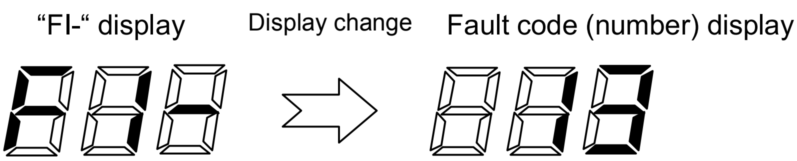
In addition, the test mode has an interlock as shown below.

- The drive equipment cannot enter the test mode while that is in operation.
- When the test mode except TEST-22 and TEST-25 is used, the drive equipment cannot finish the test mode unless operation of the drive equipment is turned off.

1.5 When a Fault Occurs

When a serious fault occurs, perform the following procedure to prevent further damage and to return the equipment to service as soon as possible.

(1) Record the fault message displayed on the operation panel.
<Standard type operation panel>
Fault code (number) appears after “FI-”.



Fault code, fault symbol and their explanation are shown in the Fault Code Table on the next page.

<High function type operation panel>
Fault symbols (alphabet) are displayed. In order of fault occurrences, from first to tenth faults are displayed. If the right arrow or enter button is pressed, it will alternate a comment display.

```
Active Fault Display
1.FUSE_                                      62
2.BLR_                                      159
3.AC_MCCB_                                  155
4.UVA                                       222
5.UV_READY                                  287
        --- RESET FAULT NOW ---
```

```
Active Fault Display
1.IGBT Fuse                                  62
2.E Critical Fault                          159
3.AC In MCCB Opn                            155
4.E Ready Cnd Met                           222
5.Elect Cond Met                            287
        --- RESET FAULT NOW ---
```

(2) Collect the trace back data.
Collect the data recorded in the non-volatile memory in the unit.
The latest 6 or 7 portions of trace back data are stored.
PC that maintenance tool is installed (option) can replay the trace back data.

(3) Check the apparent operating state of the equipment.
Perform the safety check described earlier before performing this check.
In addition, to recover from the fault, see "8 Fault and Recovery".

- Only use parts stipulated by Toshiba as replacements. Use of any parts other than those stipulated by Toshiba may result in the equipment not being able to perform as desired, and also may result in safety problems. If there are no spare parts on hand, order parts from Toshiba, or have Toshiba replace the parts.
- This equipment includes parts that require periodic replacement. See "6.4 Parts to be Regularly Renewed", for details. Be sure to order these parts in advance, since delivery may take time.

The three digits code appears after “FI-” on the standard operation panel is indicated in Table 1.5.1.

- When a fault occurs, please wait for 30 seconds before “Fault-reset-operation”.

Table 1.5.1 List of Fault Code

No.	Symbols	No.	Symbols	No.	Symbols	No.	Symbols	No.	Symbols
48	OCA	129	MPSF	208	UVS	301	SPA1	376	OL_A
49	OCD_U	130	OVP	209	IL	302	SPA2	377	CL_TA
50	OCD_V	131	OVN	210	P_SW	306	P_SW	378	GR_A
51	OCD_W	132	OVP_B	211	QSTOP_FAULT	307	QSTOP_FAULT	379	PRE_F
52	OH_T_U	133	OVN_B	212	RDIR_PROT	308	RDIR_PROT	380	CUR_DIFF
53	OH_T_V	134	GDM_F_U	213	PLL_ERR	309	PLL_ERR	381	M_FN
54	OH_T_W	135	GDM_F_V	214	MPSFA	310	MPSFA	382	GR_T
56	F_UP	136	GDM_F_W	215	ACSW_F	311	ACSW_F	383	STPRQ
57	F_VP	137	GDM_F_B_U	219	ACSW_F_B	315	ACSW_F_B	384	AIN_FAULT
58	F_WP	138	GDM_F_B_V	221	UVA_EX	317	UVA_EX	386	SOFT_STL
59	F_UN	139	GDM_F_B_W	222	UVA	318	UVA	388	OH_U
60	F_VN	141	OCA	223	C_IL	320	AIN_FAULT	389	OH_V
61	F_WN	142	OCA_B	224	AIN_FAULT	322	TL_F3	390	OH_W
64	OCA_B	143	PLL	226	TL_F3	323	TL_F4	391	OH_B_U
65	OCD_B_U	145	UVD	227	TL_F4	324	M_FN_T	392	OH_B_V
66	OCD_B_V	146	OL5	230	M_OH	325	BR_F	393	OH_B_W
67	OCD_B_W	147	OL20	231	B_HLTY	326	M_OH	398	GR
68	OH_T_B_U	150	CL_T	235	TUNE_IL	327	B_HLTY	399	SPA1
69	OH_T_B_V	151	C_FN_T	237	SPA1	331	TUNE_IL	400	ACSW_C
70	OH_T_B_W	152	ACOFF	238	SPA2	333	SPA1	401	ACSW_C_B
72	F_UP_B	153	ACP_T	240	SPA1	334	SPA2	402	GATE_U
73	F_VP_B	154	DCSW	241	SPA2	335	GR_T	403	GATE_V
74	F_WP_B	155	AC_MCCB	246	UVPSIL	336	STL_A	404	GATE_W
75	F_UN_B	159	BLR	247	ACSW_C	337	C_FN	405	GATE_U_B
76	F_VN_B	161	UVD_B	250	UVNSIL	339	C_FN_B	406	GATE_V_B
77	F_WN_B	167	C_FN_T_B	251	ACSW_C_B	340	OH_ACL	407	GATE_W_B
82	OSS	170	DCSW_B	253	M_FN	341	MTMP_S	409	SPA3
83	OSS_FO	171	AC_MCCB_B	254	SP_SIL	342	M_OH	410	VDC_IL
86	SP_ERR	176	UVP_B	255	STCMD	343	M_OH_A	411	PRE_CTT_IL
87	SP_ERR2	177	UVN_B	256	GDM_F_U	344	OL_A	412	ACP
89	CURU	178	UVP	257	GDM_F_V	345	CL_TA	413	UVPSIL
90	CURW	179	UVN	258	GDM_F_W	346	GR_A	414	UVNSIL
91	CURU_B	180	OH_ACL_T	259	GDM_F_B_U	347	PRE_F	415	UV
92	CURW_B	181	PRECHG_OH	260	GDM_F_B_V	348	CUR_DIFF	416	ACSW_T
96	F_C	182	SYS_ERR	261	GDM_F_B_W	349	M_FN	417	ACSW_T_B
97	F_C_B	183	PARA_ERR	262	GATE_U	350	GR_T	425	DS
99	GP_F	185	AC_NL	263	GATE_V	352	AIN_FAULT	426	SPA4_T
109	F_GND	186	GR_T	264	GATE_W	354	SOFT_STL	427	SPA4
110	F_PRE	187	PHASE_ERR	265	GATE_U_B	356	OH_U	428	UV
112	PLD_ERR	188	BLA	266	GATE_V_B	357	OH_V	429	P_SW
115	DS_T	189	STALL	267	GATE_W_B	358	OH_W	430	BLR
116	BLR_FAULT	191	UPS_ERR	272	TL_F1	359	OH_B_U	431	BLR_CPSF
117	CPU_A	194	TL_F1	273	TL_F2	360	OH_B_V		
118	CPU_M	195	TL_F2	274	TL_F3	361	OH_B_W		
120	SPA4_T	199	N_IM	275	TL_F4	366	GR		
121	SPA3_T	200	SPA4_T	279	TQZ_GB	367	SPA1		
122	SPA2_T	201	SPA3_T	282	ACSW_T	368	STL_A		
123	SPA1_T	202	SPA2_T	287	UV_READY	369	C_FN		
124	SPA4	203	SPA1_T	288	RNTD_C	371	C_FN_B		
125	SPA3	204	SPA4	292	M_FN_T	372	OH_ACL		
126	SPA2	205	SPA3	293	BR_F	373	MTMP_S		
127	SPA1	206	SPA2	295	CHG_START	374	M_OH		
128	CPSF	207	SPA1	298	ACSW_T_B	375	M_OH_A		

For details of the fault codes, see the troubleshooting manual (6F3A4791).

1.6 Notes on Changing Parameter Settings

The setting data for this equipment is stored in EEPROM that is nonvolatile memory, as shown in Fig. 1.6.1. When the microcontroller is started (initialized) at power on the data in EEPROM is read as indicated by (1) and that data is copied without change to RAM as indicated by (2). From that point on, the data in RAM is used to control the system as indicated by (3).

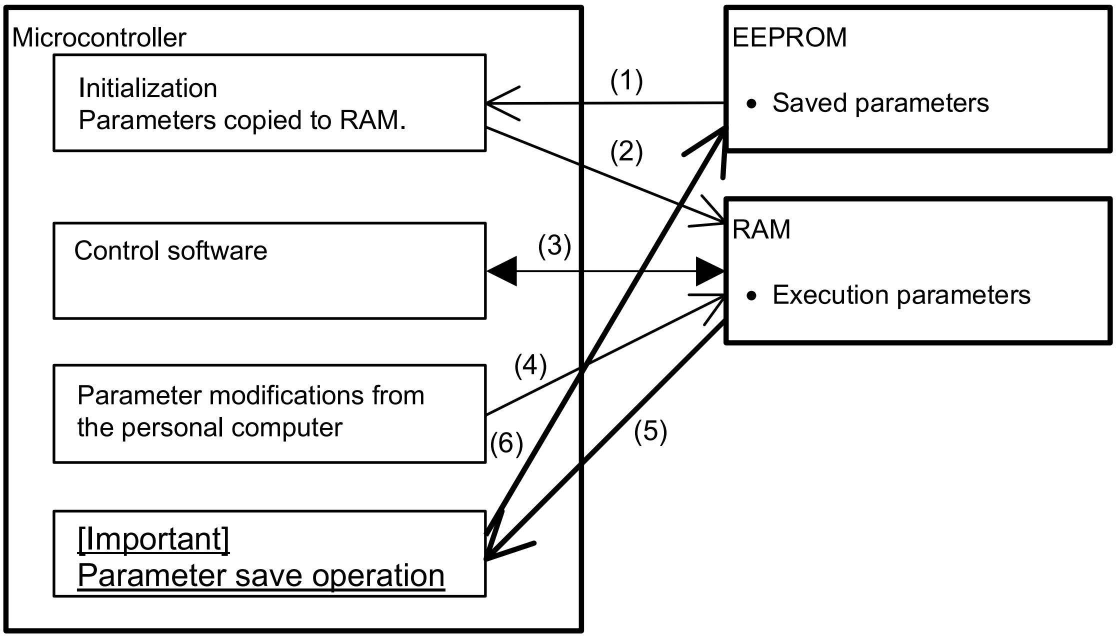


Fig. 1.6.1 Memory Structure for Parameter Settings

When modifying the parameter settings from maintenance tool on the personal computer, the execution parameters in RAM are modified. A "Set point control" operation is required to save those values. If this operation is not performed, the previous values will be restored the next time the system is initialized.

The write operation that saves the parameters (from RAM to EEPROM) may require up to dozens of seconds to complete. In addition, user comments can be attached to the setting value stored in EEPROM. Write time differs depending on the number of parameters and thus make sure to wait until the user comment will be registered (displayed) on the screen as EEPROM comment in the storage area. If the control power supply is turned off during this operation, both the RAM and the EEPROM parameters may be set to incorrect values. If incorrect values are stored, an error state (“PI-183” will be displayed) will occur the next time the control power supply is turned on, and it may become impossible to drive the motor normally. If this error state occurs, read "8 Fault and Recovery" and follow those directions to recover from the problem.

Make sure that you never cut off the control power
when writing of the setting value to the parameter storage area “EEPROM” begins
until the user comment appears in the “EEPROM” area on the personal computer screen.

2 Overview

2.1 Introduction

TMdrive-30 is a totally digital- and vector-controlled sine wave PWM inverter that performs highly precise and efficient variable speed control of AC motors with a small to medium capacity. Also, TMdrive-P30 is an IGBT converter that receives the AC power supply and converts it into the DC power for the IGBT inverter. This equipment is power supply system-friendly because it controls the input current as sin wave. Before starting operation of this equipment, thoroughly read this instruction manual to fully understand its contents.

This manual consists of the specifications of the equipment, names of blocks, concept of control, startup and operation of the equipment, fault and recovery, maintenance points, and describes maintenance and operation after the installation of the equipment.

- **Interfaces**
  For the connections with external equipment, read "3 Interface”.
- **Concept of control**
  To know how this equipment performs variable speed control over motors, read "5 Operation".
- **Startup and operation of equipment**
  For the procedure for preparations before starting the equipment and how to operate the equipment independently on an experimental basis or how to check the operation status during line operation, read "1.4 Operation".
- **Maintenance**
  For the inspection points to keep the equipment in optimal conditions and cautions on handling internal parts, read "6 Usage Notes”.
- **Fault and recovery**
  For action to be taken in the case of any fault in the equipment, read "8 Fault and Recovery".
- **Spare parts**
  For spare parts for emergency replacement, read "6.5 Recommended Spare Parts".

2.2 Description of Terminology

This section describes the special terms used in this manual.

Table 2.2.1 Description of Terminology

Technical Term	Meaning and its contents
3-level inverter	Inverter that enables 3 levels of output. The output phase voltage has three levels: (+), (0), and (-).
CTR circuit board	Main control circuit board
EEPROM	An abbreviation of Electrical Erasable Programmable Read Only Memory
GDM circuit board	Gate Drive Module A gate drive circuit board that amplifies gate signals to turn on/off the IGBT.
IGBT	An abbreviation of Insulated Gate Bipolar Transistor
LCD	An abbreviation of Liquid Crystal Display
LED	An abbreviation of Light Emitting Diode
MCCB	An abbreviation of Molded Case Circuit Breaker
NPC	Another name for a 3-level converter An abbreviation for Neutral Point Clamped
PP7	Power electronics Processor Various Inverter control Integration (VII = 7) Toshiba's 32-bits microcomputer for power electronics control
PSM	Switching power supply unit that outputs ±15 V dc and +5 V dc.
RAM	An abbreviation of Random Access Memory
TOSLINE-S20	Optical transmission device (Toshiba's product name). Exchanges operating sequence signals and operation data with an external device equipped with this transmission device.
Initialize	An initialization process. In this equipment, as the control power is turned from off to on, the data and circuits are initialized.
Interface	A method that exchanges signals between this equipment and external equipment.
Inverter	A reverse conversion circuit that converters DC main power voltage into AC voltage. (DC → AC conversion)
Inverter unit	A box containing IGBT inverter circuit and gate drive circuit board.
Converter unit	A box containing the IGBT converter circuit and gate drive circuit board.
Overload	A status, in which the current output from this equipment, exceeds the continuous rating of this equipment.
Converter	A conversion circuit that receives AC power and converts it to DC voltage (AC → DC conversion). A reversible converter also allows inverter operation but the converter connected on the power supply side is called a converter.
Common converter	DC main circuit power supply for TMdrive-30. This unit is used as common power supply. TMdrive-P30, TMdrive-T30, and TMdrive-D30 series are provided.
Operation panel	A panel used for data display and basic operation.
Load	A motor that receives the power from TMdrive-30
ASC	An abbreviation for ACTIVE STAR COUPLER. Equipment that performs transmission signal branching for the Toshiba optical transmission device TOSLINE-S20.
TOSLINE-S20	Optical transmission device (Toshiba's product name). Exchanges operating sequence signals and operation data with an external device equipped with this transmission device.

2.3 Specifications of TMdrive-30 and TMdrive-P30

This section describes the features of TMdrive-30 and specifications of TMdrive-P30.

2.3.1 Features

(1) **High performance and high reliability**
Use of a large capacity IGBT improves the reliability, reduces the switching loss, and improves the control performance. The control circuit uses a newly developed power electronics equipment control processor PP7 and an eight-layered surface mounting circuit board, ensuring high component integration and high reliability.

(2) **Highly precise speed control (TMdrive-30)**
Use of totally digital and vector control ensures highly precise speed control and high speed response.
(ωc = 60 rad/s, ωc = 20 rad/s for speed sensor-less control)

(3) **Transient response and stability**
Use of totally digital and vector control makes it possible to ensure stable operation characteristics including the transient status.

(4) **Quadrantal operation (TMdrive-30)**
Quadrantal operation, normal, reverse, power running, and regenerative operations are made smoothly.
(Note: This feature applies only when the reverse-parallel thyristor converter (TMdrive-T30) or IGBT converter (TMdrive-P30) is used.)

(5) **Supporting various speed sensors (TMdrive-30)**
Drives a squirrel-cage induction motor. A pulse generator or high-resolution brushless resolver can be used as a speed detector installed in the motor. Speed sensor-less vector control is also possible.

(6) **High power factor (TMdrive-P30), high efficiency**
A high efficiency drive system can be constructed due to high efficiency achieved by sine wave PWM control and small device loss. Because TMdrive-P30 can control the power waveform as sine wave, it reduces power supply higher harmonic waves and can control the power supply factor as high as 1.

(7) **Energy saving**
With combined with a common converter (TMdrive-P30, TMdrive-T30 (reverse-parallel type)) having power regeneration function, the energy is saved in applications where continuous regenerative operation is made, or the acceleration and deceleration are made repeatedly.
The regenerative energy is stored as DC voltage and used to drive other inverters. Additionally, the power is regenerated to the AC power supply by the common converter with the power regeneration function.

(8) **Maintenance tool (optional test and adjustment support tool)**
Not only as a maintenance, monitoring, and fault analysis tool, this tool can also be used as an adjustment tool. To change the parameters and collect traceback data, this tool is required.

(9) **Main unit (PC) transmission**
Transmission via Toshiba integrated controller (V series) and TOSLINE-S20 can be performed. This equipment also supports open transmission such as ISBus, Profibus, and DeviceNet (optional).

2.3.2 General Specifications (Structure)

The general specifications (structure) of the equipment are shown in below.

Table 2.3.1 General Specifications (Structure) (TMdrive-30, TMdrive-P30)

Item			Standard specification	Optional specification	Remarks
Installation environment			Temperature: 0 to 40°C Humidity: 85% maximun Altitude: 1000 m maximum above sea level Vibration: 10 to 50 Hz, 0.5 G maximum Installation location: Indoors No corrosive gas	Humidity: 95% maximum (Measures against dew condensation, such as a space heater, are required)	If altitude is more than 1000 m, dilate the specification at the rate of 1%/200 m.
Panel dimensions			Height: 2300 mm Depth: 800 mm Note: Width varies with inverter capacity.		
Panel Type			TMEIC panel enclosure		
Protection structure type			Semi-closed enclosure (IP20) Conforms to JEM-1267 (1975)	[1] IP32	
Enclosure plate thickness			Door: 2.3 mm Rear and side panels: 1.6 mm		
Coating	Paint color		Enclosure: JEM1135 (1982) 5Y7/1 Channel base and hoist angle: N1.5 Internal panels are not painted (except some specific area)	[1] Other specified color (Only for enclosure)	
Coating	Coating thickness		External surface: approx. 40 μm Internal surface: approx. 30 μm	[1] Customer specification is acceptable.	
Screws			Metric screws (ISO)		
Nameplate	Panel name and panel No.	Material	Acrylic (affixed)		
Nameplate	Panel name and panel No.	Dimensions	Panel name: 250 mm (wid.) × 31.5 mm (hgt) Panel number: 63 mm (wid.) × 31.5 mm (hgt)		
Nameplate	Panel name and panel No.	Style and No. of chars	Style: Round Gothic (Japanese or English) No. of chars: Panel name: up to 27 chars Panel No: up to 13 chars Plate color: White, Char. Color: black		

2.3.3 General (Electrical) Specifications

The general (electrical) specifications for the equipment are shown in below.

Table 2.3.2 General (Electrical) Specifications (TMdrive-30, TMdrive-P30)

Item		Standard specification	Optional specification
Control method		3-level PWM method	
Input voltage		See the detailed explanation in 2.3.10, "Ratings."	
Output voltage			
Capacity lineup			
Output rated current			
Generated loss			
Motor to drive		Squirrel-cage induction motor (TMdrive-30)	
Control power	Power supply and fluctuation range	200 V ac, 50 Hz or 200/230 V ac, 50/60 Hz Voltage fluctuation range:	380 V ac - 5 Hz: Step-down transformer is required separately. Regulation: ±10%
Control power	Required capacity	2000 frames or less (1 bank) 1 kVA 4000 frames or less (2 banks) 2 kVA	
Control power	Interrupting capacity	25 kA or less	
Main circuit	PWM frequency	1.5kHz	
Main circuit	Regenerative method	Power regeneration by the converter or mounting a regenerative resistance in the converter	
Other	Grounding protection (Detection)	Not provided: TMdrive-30 Provided: TMdrive-P30	
Other	Schematic diagram code	IEC-60617 (JIS C0301 Group 1)	
MMI	Display unit (Standard or high-function type selection)	Standard unit Display: 7-segment LED × 3 Operation unit: Fault reset switch Panel interlock switch Status display LED × 3 Other: Tool I/F connector	High-function unit Display: Monochrome display graphic module 240 × 64 dots LCD Operation unit: Keypad Fault reset switch Panel interlock switch Status display LED × 3 Other: Tool I/F connector (See other pages for details.)
MMI	Maintenance tool	Not provided	PC tool
I/O	Analog input	Differential 2 ch, ±10 V (Isolator not required)	
I/O	Analog output	Differential 2 ch, ±10 V (Isolator not required)	
I/O	Digital input	Multi-level (24-110 V dc, 48-120 V ac) 2 ch (One of them is its usage fixed.) External power can be used. 24 V dc, 6 ch (only for internal power supply)	
I/O	Digital output	No. of channels: 24 V dc, 6 ch	
I/O	PLG pulse output (TMdrive-30)	Single end 2-phase type	
Sensor	Speed sensor (TMdrive-30)	Differential rotary encoder (PD) or single end type rotary encoder	Resolver (1× and 4× both are enabled.)

2.3.4 TMdrive-30 Control Specifications (Speed sensor: PLG)

The table below shows the TMdrive-30 control specifications when the speed sensor is PLG.

Table 2.3.3 TMdrive-30 Control Specifications (Speed sensor: PLG)

Item	Standard specification	Optional specification
Required hardware	None	
Output frequency range	0 to 120 Hz	
Motor rotation speed	4 poles: 3600 min-1 (Max) 2 poles: 7200 min-1 (Max)	
Number of motors to drive	One unit	
Speed sensor (PLG) input condition	PLG with 2-phase output must be used. (Frequency: 100 kHz maximum)	
PLG pulse output	Through output of the same pulse signals as PLG input (Max. 10kHz)	
Speed control range	0% to 100% Torque is limited at very low speed	
Speed control accuracy (Rated speed: 100%)	±0.01% with digital input ±0.1% with analog input	
Speed setting resolution	1/25000 (digital setting) 1/1000 or more (analog setting)	
Speed response	ωc = 60 rad/s (Max)	
Torque control range	0 to 100%	
Torque control accuracy	±30% without R2 compensation	±3% with R2 compensation * Motor temperature sensor is required.
R2 compensation (Torque compensation with motor temperature sensor)	Not provided	Provided (The following motor sensor is required.) [1] Platinum resistance [2] RTD unit These are listed as optional devices.
Field weakening range (Base speed: Top speed)	1:3	1:5
Current response	ωc = 1000 rad/s (Max)	
Current control accuracy	±2%	

2.3.5 TMdrive-P30 Control Specifications (Speed sensor: Resolver)

The table below shows the TMdrive-30 control specifications when the speed sensor is a resolver.

Table 2.3.4 TMdrive-P30 Control Specifications (Speed sensor: Resolver)

Item	Standard specification	Optional specification
Output frequency range	0 to 120 Hz	
Motor rotation speed	4 poles: 3600 min^{-1} (Max) 2000 min^{-1} for 4X type 2 poles: 3600 min^{-1} (Max)	
Number of motors to drive	One unit	
Speed sensor (resolver) input condition	Brushless resolver (1 kHz or 4 kHz) 1x type and 4x type can be used.	
PLG pulse output	Available to output 2^n pulse	
Speed control range	0% to 100% Torque is limited at very low frequency	
Speed control accuracy (Rated speed: 100%)	±0.01% with digital input ±0.1% with analog input	
Speed setting resolution	1/25000 (digital setting) 1/1000 or more (analog setting)	
Speed response	ωc = 60 rad/s (Max)	
Torque control range	0 to 100%	
Torque control accuracy	±30% without R2 compensation	<Optional> ±3% with R2 compensation * Motor temperature sensor is required.
R2 compensation (Torque compensation with motor temperature sensor)	Not provided	Provided (The following motor sensor is required.) [1] Platinum temperature sensor [2] RTD unit These are listed as optional devices.
Field weakening range (Base speed: Top speed)	1:5	
Current response	ωc = 1000 rad/s (Max)	
Current control accuracy	±2%	

2.3.6 TMdrive-30 Control Specifications (Speed Sensor-less Vector Control)

The table below shows the TMdrive-30 control specifications for speed sensor-less vector control.

Table 2.3.5 TMdrive-30 Control Specifications (Speed Sensor-less Vector Control)

Item	Standard specification	Optional specification
Required hardware	None	
Output frequency range	1.8 to 120 Hz	1.0 to 120 Hz
Motor rotation speed	4 poles: 3600 min^{-1} (Max) 2 poles: 7200 min^{-1} (Max)	
Number of motors to drive	One unit	
Speed sensor	None	
Speed control range	3% to 100% Torque is limited at very low frequency	
Speed control accuracy (Rated speed: 100%)	±0.5% with digital input ±0.5% with analog input	
Speed setting resolution	1/25000 (digital setting) 1/1000 or more (analog setting)	
Speed response	ωc = 20 rad/s (Max)	
Torque control range	Not applicable	
Torque control accuracy		
R2 compensation (Torque compensation with motor temperature sensor)	Not provided. However, motor overheat protection is possible.	
Field weakening range (Base speed: Top speed)	1:1.5	
Current response	ωc = 1000 rad/s (Max)	
Current control accuracy	±2%	

2.3.7 TMdrive-30 Control Specifications (Speed Sensor-less Vector Control with Driving Multiple Motors)

The table below shows the TMdrvie-30 control specifications for multiple motor drive speed sensor-less vector control.

Table 2.3.6 TMdrive-30 Control Specifications
(Speed Sensor-less Vector Control with Driving Multiple Motors)

Item	Standard specification	Optional specification
Required hardware	None	
Output frequency range	1.8 to 120 Hz	
Motor rotation speed	4 poles: 3600 min^{-1} (Max) 2 poles: 7200 min^{-1} (Max)	
Speed sensor	None	
Speed control range	5% to 100% Torque is limited at very low frequency	
Speed control accuracy (Rated speed: 100%)	±1.0% with digital input ±1.0% with analog input	
Speed setting resolution	1/25000 (digital setting) 1/1000 or more (analog setting)	
Speed response	ωc = 15 rad/s (Max)	
Torque control range	Not applicable	
Torque control accuracy		
R2 compensation (Torque compensation with motor temperature sensor)	Compensation is possible with one representative unit. Motor overheat protection is possible.	
Field weakening range (Base speed: Top speed)	1:1.2	
Current response	ωc = 1000 rad/s (Max)	
Current control accuracy	±2%	
Minimum number of units to drive	Not provided	Provided Max current detection board is required. (Refer to the optional devices.)
Variation range of the number of units	Not provided	The number of units to disconnect is up to 50% (When all of the units are connected, it is assumed to be 100%)
Connecting additional motors while operating	Not provided	Possible if the following conditions are met: Caution plates must be affixed. • The speed must be 30% maximum of the rated speed. • The number of units must be 50% maximum of the connected units. For ordering information of caution plates, refer to the optional devices.

2.3.8 TMdrive-30 Control Specifications (V/f control)

The table below shows the TMdrive-30 control specifications for V/f control.

Table 2.3.7 TMdrive-30 Control Specifications (V/f control)

Item	Standard specification	Optional specification
Required hardware	None	
Output frequency range	0.0 to 120 Hz	0.0 to 120Hz
Motor rotation speed	4 poles: 3600 min^{-1} (Max) 2 poles: 7200 min^{-1} (Max)	
Speed sensor	None	
Speed control	None	
Speed setting resolution	1/25000 (digital setting) 1/1000 or more (analog setting)	
Current control	None	
Current limit function	Equipped Current limit: 0 ~ 400%	
Slip frequency compensation	Equipped Rated slip frequency: 0 ~ 10%	

2.3.9 TMdrive-30 Control Specifications

The table below shows the TMdrive-P30 Control Specifications.

Table 2.3.8 TMdrive-30 Control Specifications

Item	Standard specification	Optional specification
Basic control method	Voltage control + power factor control + dp axis current control	
Voltage control range	AC input voltage effective value x $\sqrt{2}$ or more 1800Vdc or less	
Voltage control accuracy	±5%	
Voltage response	ωc= 60rad/s (max.)	
Restart at instantaneous power failure	Not provided	Provided

2.3.10 Ratings

Tables 2.3.9, 2.3.10 and 2.3.11 list the ratings in the TMdrive-30 and TMdrive-P30 standard specifications.

Tables 2.3.12 and 2.3.13 list the ratings with over-load level in the TMdrive-30 and TMdrive-P30.

Table 2.3.9 TMdrive-30 Ratings Table (Standard Specifications)

Frame size	Output capacity [kVA]	DC voltage [Vdc]	AC voltage [Vac]	Rated current [Arms]	DC distribution capability [%]	DC distribution capability [Adc]	Generated loss [kW]
1500	1500	2×900	1250	693	70	686	18.5
2000	2000			924	70	914	24.5
3000	2×1500			2×693	70	2×686	37.5
4000	2×2000			2×924	70	2×914	49.5

(Note) Generated loss is an approximate value.

Table 2.3.10 TMdrive-P30 Ratings Table (Standard Specifications)

Frame size	Output capacity [kVA]	DC voltage [Vdc]	AC voltage [Vac]	Rated input current [Arms]	Rated output current [Adc]	Generated loss [kW]	Input power factor
2000	1700	2×900	1100V±10%	929	944	34	0.95 or more
4000	2×1700	2×900	1100V±10%	2×929	2×944	2×34	0.95 or more

Where, the rated input current is a value when

input voltage = 1100Vac
input power factor = 0.98
Device efficiency = 0.98

The output capacity is a value when the input voltage is 1100 V ac or more. The output capacity when the input voltage is below 1100Vac is as follows:

Output capacity [kW] = 1700 x (input voltage effective value) / 1100 Vac (See Figure Fig. 2.3.1).

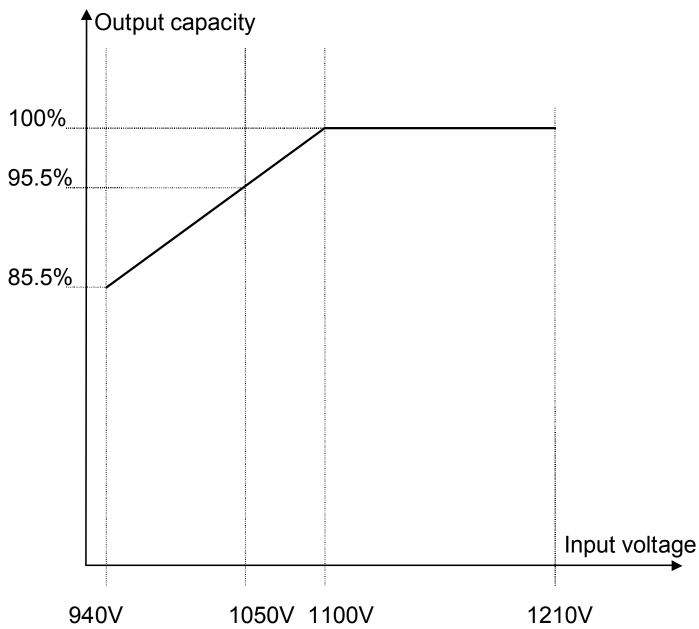


Fig. 2.3.1 Relationship between input voltage and Output Capacity

Table 2.3.11 Ratings Table (Standard Specifications)

Converter			Inverter output voltage	
Type	Rated input voltage	Converter input regulation	Vector control with sensor	Sensor-less vector control
Thyristor	2×900Vac	±10%	1250Vac	1200Vac
IGBT	1100Vac	±10%	1250Vac	1200Vac
Diode	2×700Vac	±10%	1150Vac	1100Vac
		±5%	1200Vac	1150Vac
		+10%/–0%	1250Vac	1200Vac

Table 2.3.12 Ratings with over-load level (TMdrive-30)

Frame	DC voltage Vdc	AC voltage Vac	Rated AC current Arms				
			OL150% -60s	OL175% -60s	OL200% -60s	OL250% -60s	OL300% -60s
1500	1800	1250	693	594	520	416	347
2000			924	792	693	554	462
3000			1386	1188	1040	832	693
4000			1848	1584	1386	1109	924

Table 2.3.13 Ratings with over-load level (TMdrive-P30)

Frame	DC voltage Vdc	AC voltage Vac	Rated AC current Arms				
			OL150 % -60s	OL175% -60s	OL200% -60s	OL250% -60s	OL300% -60s
2000	1800	1100±10 %	929	796	697	557	465
4000			1858	1593	1394	1115	929

2.3.11 Protective Functions

Fig. 2.3.2 shows the protection schematic diagram of TMdrive-30. Fig. 2.3.3 shows the protection schematic diagram of TMdrive-P30.

The equipment is protected not only by current and voltage signals but also by protection detection in the control circuit.

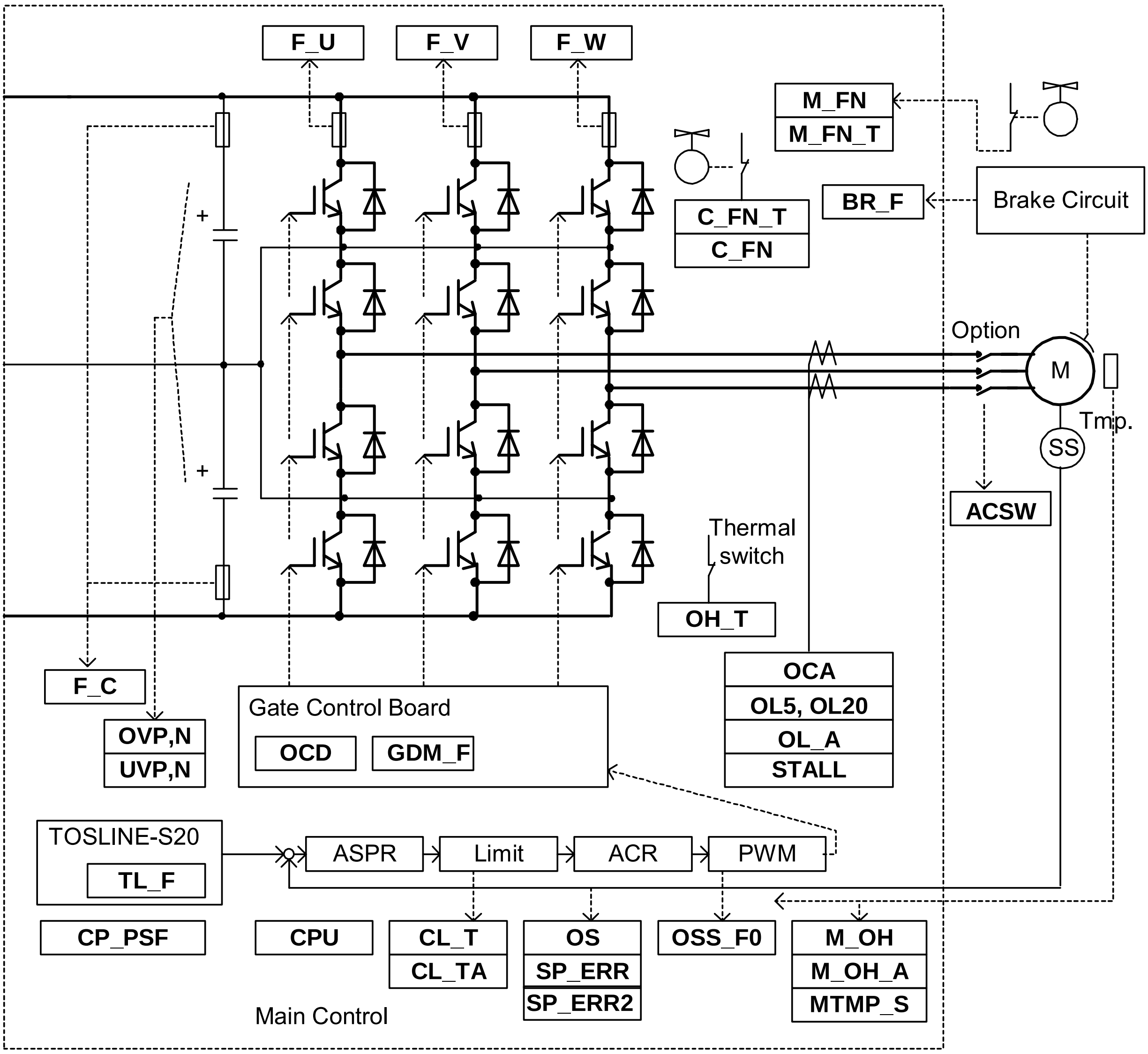


Fig. 2.3.2 TMdrive-30 Protection System Diagram

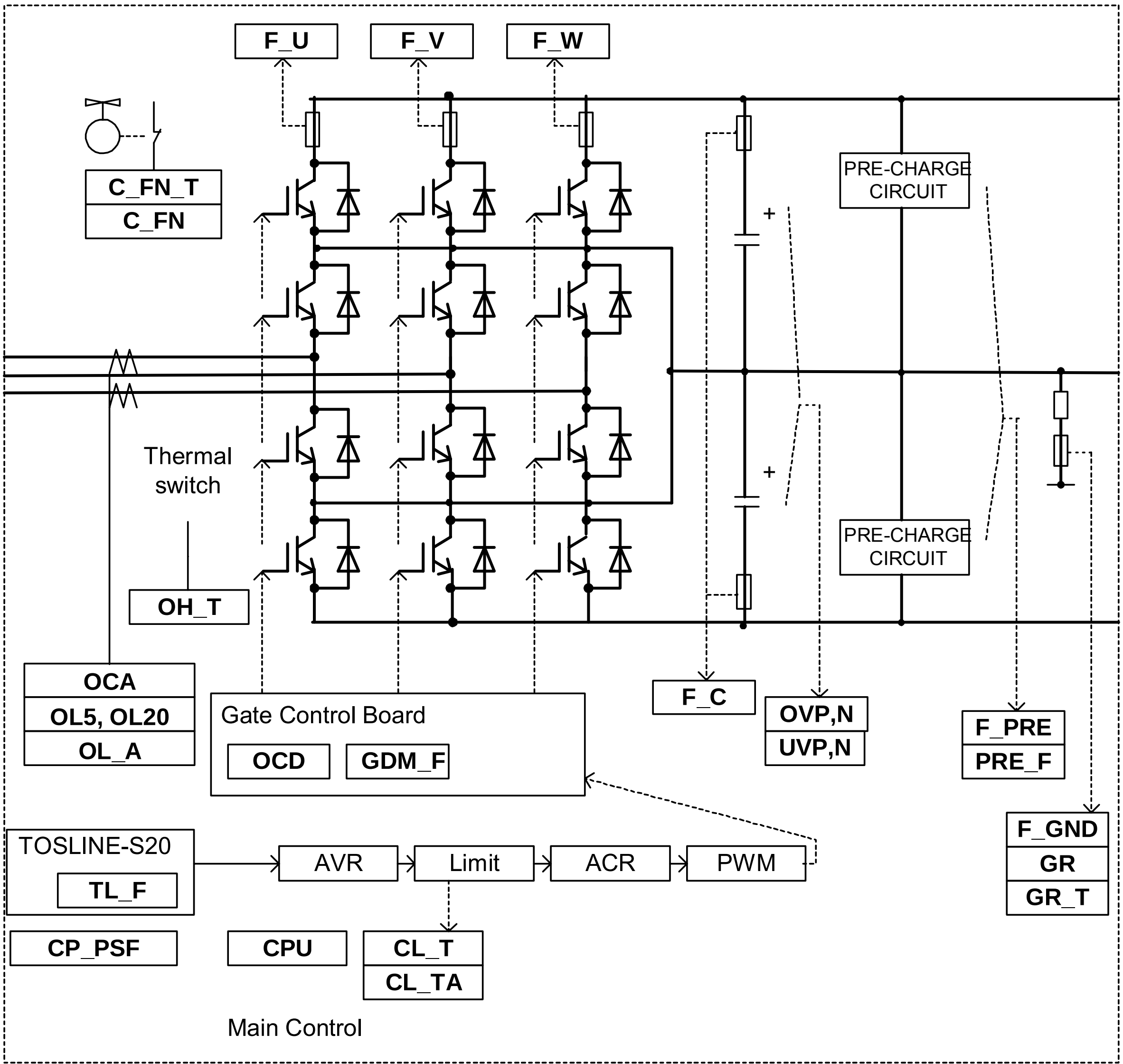


Fig. 2.3.3 TMdrive-P30 Protection System Diagram

Each protection function is shown in below.

2.3.11.1 Current-related protection

(1) AC over-current OCA
When the output current exceeds the setting value, overcurrent is detected and an instantaneous trip occurs.
Operation level is automatically set from CS_FRAME_SIZE, CS_EOUIP_CURR, AND CS_VOLT_RANK. The operation level varies depending on the equipment and it is approx. 50 to 100% of the overload rating. Manual setting for $CP_OCA is also possible.

(2) IGBT overcurrent OCD
If IGBT malfunctions in the voltage type inverter and converter, two IGBTs in the same phase may turn on, resulting in DC short-circuit. In this case, the charged capacitor is short-circuited with an IGBT element, excessive current is flown to the IGBT element, and the gate signal of the IGBT becomes abnormal. This condition is detected and an instantaneous trip occurs.

(3) Overload detection OL5, OL20,OL_A
5-minute and 20-minute RMS computation of the output current is performed and when the predetermined value is exceeded, activated.
5-minute RMS setting or 20-minute RMS setting is provided.
$CP_RMS_5 : 5-minute RMS protection
$CP_RMS_20 : 20-minute RMS protection
$CP_RMS_A5 : 5-minute RMS alarm
$CP_RMS_A20 : 20-minute RMS alarm

<Example> The equipment allows the following operation pattern. Therefore, the setting value is 5-minute RMS when overload rated current (for example, 150%) continues for one minute after 100% continuous operation.

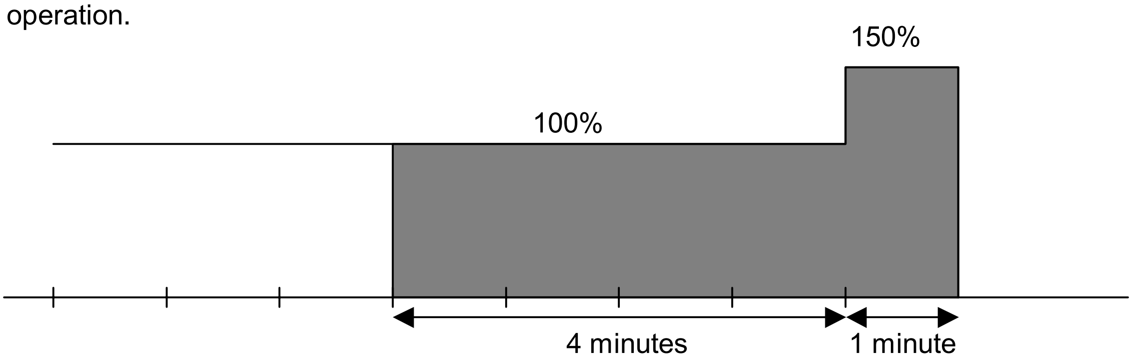


Fig. 2.3.1 Allowable Overload Operation Pattern

$$\$CP\_RMS\_5 = \sqrt{(1^2 \times 4 + 1.5^2 \times 1)/5} = 1.118 = \mathbf{111.8}\ \%$$

$$\$CP\_RMS\_20 = \sqrt{(1^2 \times 19 + 1.5^2 \times 1)/5} = 1.03 = \mathbf{103.1}\ \%$$

(4) Current limit timer CL_T,CL_TA
When the current limit is reached for the predetermined time period, CL_T is detected.
The standard setting is CL = 60.0 (s).
This function provides an alarm. A current limit alarm (CL_TA) is detected at TIME_CL x 80%.

(5) Low frequency overload STALL (TMdrive-30)
This is detected when large load is applied at low frequency.

2.3.11.2 Voltage Protection

(1) DC overvoltage OVP,OVN
Activated when the DC voltage supply exceeds the setting value.
The operation level is automatically set to 120% of the equipment rating from CP_OV_LVL and CS_DC_VOLT. Manual setting for $CP_OV is also possible.

(2) DC undervoltage UVP,UVN
Activated when the DC voltage supply drops below the setting value.
The standard setting is DC undervoltage (UVP, UVN) detection level = 50.0%.

2.3.11.3 Motor Speed Protection (TMdrive-30)

(1) Overspeed OSS
Overspeed is detected when the motor speed exceeds the preset speed.
The standard setting is $CP_OSP = 115.0%.

(2) Overfrequency OSS_FO
Excessive output frequency is detected when the output frequency exceeds the setting value.
As the standard setting, the frequency [Hz] corresponding to 115% of the maximum frequency is set at $CP_OSS_FO.
For operation up to 50Hz, set $CP_ISS_FO = 58 Hz.

(3) Speed detection error SP_ERR, SP_ERR2
Activated when a speed sensor error (disconnection, etc.) is detected.
When a resolver is used as the speed sensor and when sensor-less speed control is used, SP_ERR is activated upon error detection.
When PLG is used as the speed sensor, SP_ERR2 is activated upon error detection.

2.3.11.4 Control Circuit and Power Supply

(1) Control power supply failure CPSF
Activated when the control power supply drops below the control power loss detection level.
The higher the setting level, the shorter the time it takes to detect control power loss.
In the standard setting, PSF = 140.0 (V) is set when restart at power failure (optional) is not provided and 160.0 V is set when restart at power failure (optional) is provided.

(2) Gate power supply failure GDM_F
The power for the gate is supplied from the control power supply via the switching transformer on the gate board. An error on this circuit (board) is detected.

(3) Equipment ventilation fan stop C_FN,C_FN_T
Activated when the cooling fan for the equipment stops.
The common use is that an alarm is output with a C_FN signal and the equipment is stopped when a C_FN_T is activated after an elapse of time specified by the TIME_CFAN timer.
The standard setting is TIME_CFAN = 10.0 (s).

(4) Equipment overheat timer OH_T
A temperature sensor is attached to the IGBT cooling fan of the equipment. If this is activated, the equipment stops after an elapse of time specified by the TIME_OH timer.
The standard setting is TIME_OH = 5.0 (s).

(5) Phase fuse blown F_U,V,W
A fuse is provided for each phase to prevent damage expansion at short-circuit occurrence. A blown fuse is detected by the microswitch.

(6) Capacitor fuse blown F_C
A fuse is provided in the capacitor unit to prevent damage expansion at short-circuit occurrence. A blown fuse is detected by the mocroswitch.

(7) Output contactor open ACSW (optional) (TMdrive-30)
When the output contactor that should be on is off, an ACSW error is detected.

(8) Output open AC_NL (TMdrive-30)
AC_NL is detected when the output open state is detected.

(9) CPU error CPU_A, CPU_M
An error is detected (by watchdog detection) in the microprocessor that performs control operation.
A CPU error in the circuit board is detected by hardware to protect CPU.

(10) Transmission error TL_F1 ~ TL_F4
An error is detected in main unit transmission and transmission between drives.

(11) Pre-charge fuse blown F_PRE (TMdrive-P30)
A fuse is provided on the pre-charge circuit to prevent damage expansion at short-circuit accident occurrence. A blown fuse is detected by the microswitch.

(12) Grounding fuse blown F_GND (TMdrive-P30)
A fuse is provided on the grounding circuit to prevent damage expansion at grounding accident occurrence. A blown fuse is detected by the microswitch.

2.3.11.5 Protection Associated with Motor and Break (TMdrive-30)

(1) Motor overheat M_OH,M_OH_A
When a temperature sensor is provided (optional) for the motor, temperature is detected to protect the motor.
The standard setting is $CP_MOTOR_OH = 155°C.
An M_OH_A alarm is activated at 10°C lower (fixed) than this setting value.

(2) Motor temperature detector fault MTMP_S
When the temperature of the motor temperature sensor above exceeds 200°C (fixed value), a sensor fault is assumed and MTMP_S is detected.

(3) Motor cooling fan stop M_FN,M_FN_T
If the motor cooling fun circuit is located outside, the operation signal of the cooling fan circuit is connected to the inverter. This enables the motor cooling fan interlock to be set.
It is also possible to output an alarm to outside by an M_FN signal and stop the equipment when an M_FN_T signal is activated after an elapse of time specified by the TIME_MFAN timer.
The standard setting is TIME_MFAN = 0.0 (s).

(4) Electromagnetic brake energizing circuit fault BR_F
When an electromagnetic brake is provided optionally, brake energizing circuit fault is detected.

2.3.11.6 Operation-related protection

(1) External safely switch UVS
This is a hardware interlock signal to operate the equipment. When this switch is turned off, the equipment stops by hardware logic, regardless of the equipment's software.

(2) External equipment electrical ready condition UVA_EX
This is an interlock signal to operate the equipment. When this switch is turned off, the equipment stops.

(3) External interlock IL
This is an operation interlock signal from external devices. This signal is a hardware or serial transmission signal.

(4) Panel safety switch P_SW
This is an interlock switch on the panel. With this switch, operation can be stopped from the panel.

2.3.11.7 Pre-charge-related protection (TMdrive-P30)

(1) Pre-charge failure PRE_F
When pre-charge failure (such as pre-charge circuit contactor fault or blown fuse) is detected, PRE_F is detected.

2.3.11.8 Grounding detection-related protection (TMdrive-P30)

(1) Converter grounding detection GR
GR is detected when abnormal current is detected in the grounding circuit that is grounded with main circuit via high resistance.

(2) Converter grounding detection timer GR_T
Activated when abnormal current is detected in the grounding circuit.
The common use is that an alarm is output to outside with a GR signal and the equipment is stopped when a GR_T signal is activated after an elapse of time specified by the TIME_GR timer.
The standard setting is TIME_GR = 0.1 (s).

Table 2.3.14 and Table 2.3.15 show the main protective functions of TMdrive-30 and TMdrive-P30 respectively.

*1 and *2 in the tables represent the following notes.

*1) Detection
Hardware: Items that all IGBT is directly turned off by hardware.
Software: Items that detects an error via software and activities a protection linked operation.

*2) Items with a “Yes” mark and “(Yes)” mark are selectable items by parameter settings.
The standard setting is the “Yes” mark side. To set to the “(Yes)” mark side, consider the setting carefully from a viewpoint of the system.

Table 2.3.14 Main Protective Functions of TMdrive-30

Item	Abbreviation	Detection *1		Linked operations *2				Related setting
		Hardware	Software	Major fault		Medium fault	Minor fault	
				Coast stop	Dec stop	Stop request	Alarm	
AC overcurrent	OCA	Yes		Yes				$CP_OCA
DC overvoltage (P,N)	OVP, OVN	Yes		Yes				$CP_OV
DC overcurrent	OCD	Yes		Yes				
CPU failure	CPU_A,CPU_M	Yes		Yes				
Gate power supply failure	GDM_F	Yes		Yes				
External safety switch	UVS	Yes		Yes				
Panel safety switch	P_SW	Yes		Yes				
Phase fuse blown	F_U,V,W		Yes	Yes				
Capacitor fuse blown	F_C		Yes	Yes				
External interlock	IL		Yes	Yes				
Transmission error	TL_F1~4		Yes	Yes				
Overspeed	OSS		Yes	Yes				$CP_OSP
Speed detection error	SP_ERR		Yes	Yes				
External equipment electrical ready condition	UVA_EXT		Yes	Yes		(Yes)		
Equipment ventilation fan stop timer	C_FN_T		Yes	Yes				$TIME_CFAN
Control power source failure	CPSF		Yes	Yes				$CP_PSF
Current limit timer	CL_T		Yes	Yes				$TIME_CL
DC voltage drop (P,N)	UVP, VVN		Yes	Yes		(Yes)		
Overload (5 min)	OL5		Yes	Yes		(Yes)		$CP_RMS_5, $CP_RMS_A
Overload (20 min)	OL20		Yes	Yes		(Yes)		$CP_RMS_20, $CP_RMS_A20
Equipment overheat timer	OH_T		Yes	Yes				$TIME_OH
Output open	AC_NL		Yes	Yes				
Low frequency overload	STALL		Yes	Yes				
Motor cooling fan stop	M_FN_T		Yes		Yes			$TIME_MFAN
Electromagnetic brake energizing circuit fault	BR_F		Yes		Yes			$TIME_BR
Equipment overheat	OH		Yes			Yes		
Motor cooling fan stop	M_FN		Yes			Yes	(Yes)	
Current limit alarm	CL_TA		Yes			Yes	(Yes)	
Equipment ventilation fan stop	C_FN		Yes			Yes	(Yes)	
Motor overheat	M_OH		Yes			Yes	(Yes)	
Motor temperature detector fault	MTMP_S		Yes			Yes	(Yes)	
Overload alarm	OL_A		Yes			Yes		
Motor overheat alarm	M_OH_A		Yes			Yes	Yes	

Table 2.3.15 Main Protective Functions of TMdrive-P30

Item	Abbreviation	Detection *1		Linked operations *2				Related setting
				Major fault		Medium fault	Minor fault	
		Hardware	Software	Current input breaker trip	Gate block stop	Stop request	Alarm	
AC overcurrent	OCA	Yes		Yes	Yes			$CP_OCA
DC overvoltage	OVP, OVN	Yes			Yes			$CP_OV
DC overcurrent	OCD	Yes		Yes	Yes			
CPU failure	CPU_A,CPU_M	Yes		Yes	Yes			
Gate power supply failure	GDM_F	Yes			Yes			
External safety switch	UVS	Yes			Yes			
Panel safety switch	P_SW	Yes			Yes			
Phase fuse blown	F_U,V,W		Yes	Yes	Yes			
Capacitor fuse blown	F_C		Yes	Yes	Yes			
Main power supply failure	MPSF		Yes	Yes	Yes			$CP_VREC_MPSF
Power supply synchronization PLL error	PLL		Yes	Yes	Yes			
Equipment overheat timer	OH_T		Yes	Yes	Yes			$TIME_OH
External interlock	IL		Yes		Yes			
Transmission error	TL_F1~4		Yes		Yes			
External equipment electrical ready condition	UVA_EXT		Yes		Yes			
Equipment ventilation fan stop timer	C_FN_T		Yes		Yes			$TIME_CFAN
Control power source failure	CPSF		Yes		Yes			$CP_PSF
Current limit timer	CL_T		Yes		Yes			$TIME_CL
DC voltage drop (P,N)	UVP, VVN		Yes		Yes			
Overload (5 min)	OL5		Yes		Yes			$CP_RMS_5, $CP_RMS_A
Overload (20 min)	OL20		Yes		Yes			$CP_RMS_20, $CP_RMS_A20
AC input breaker open timer	ACSW_T		Yes		Yes			
Grounding detection timer	GR_T		Yes		Yes			$CP_GDI
Equipment overheat	OH		Yes			Yes		
Equipment ventilation fan stop	C_FN		Yes			Yes	(Yes)	
Initial charge failure	PRE_F		Yes			Yes	(Yes)	
Current limit alarm	CL_TA		Yes			Yes	(Yes)	
Overload alarm	OL_A		Yes			Yes		
Grounding detection alarm	GR_A		Yes			Yes	(Yes)	

2.4 Product Code

Products codes are explained as follows.

2.4.1 TMdrive-30

The configuration of product code used for TMdrive-30 is shown below. First 9 letters are shown on the inverter rated plate. See the schematic diagrams for optional functions.

Table 2.4.1 Product Code

Column 1 5 6 7 10 11

V T 3 ■ □ ✶ ◆ ○ ●

1 ~ 4	5 □	6 ✶	7 ~ 9 ◆	10 ○	11 ●
Model name	Type	Output voltage	Frame size	S/V classification 1	S/V classification 2
■: 5 TMdrive -30	Enter the panel structure	Enter the output voltage class	Enter the frame size		Specify whether special specifications are required or not.
	J: Japanese model	C: 1200V system	1500: 152	Blank Standard	Blank Standard
			2000: 202		V: Special specifications are applied (Specify when job No. is issued.)
			3000: 302		
			4000: 402		
Indication range of nameplate					

<Product code example>
VT35JC152
VT35 TMdrive-30
J Japanese specifications
C Output voltage class: 1200V system (1250V)
152 1500 frame (1500kVA)

2.4.2 TMdrive-P30

The configuration of production code used for TMdrive-P30 is shown below. First 9 letters are shown on the inverter rated plate. See the schematic diagrams for optional functions.

Table 2.4.2 Products Code

Column 1 5 6 7 10 11

V T 3 ■ □ ✶ ◆ ○ ●

1 ~ 4	5 □	6 ✶	7 ~ 9 ◆	10 ○	11 ●
Model name	Type	Voltage	Frame size	S/V classification 1	S/V classification 2
■: G TMdrive-P30	Enter the panel structure	Enter the input voltage class	Enter the frame size		Specify whether special specifications are required or not.
	J: Japanese model	C: 1200V system	2000: 202	Blank Standard	Blank Standard
			4000: 402		V: Special specifications are applied (Specify when job No. is issued.)
Indication range of nameplate					

<Product code example>
VT3GJC202
VT3G TMdrive-P30
J Japanese specifications
C Output voltage: 1200V system (1100V)
202 2000 frames (1700kW)

3 Interface

The interface of TMdrive-30 and TMdrive-P30 with external devices consists of two major interface systems, power supply system interface and control system interface.

3.1 Power System Interface and Grounding

3.1.1 Power supply

3.1.1.1 TMdrive-30

TMdrive-30 requires the main circuit DC power supply 2x900Vdc and control power supply 220/230Vac, 60Hz or 200Vac, 50Hz. The main circuit DC power supply 2x900Vdc is received at 90P1, 90C1, and 90N1 of the power supply conductor (called "common bus" hereafter) located at the bottom of the enclosure.

Power is supplied to the common bus from a separately installed common converter (such as TMdrive-P30). 220/230Vac-60Hz or 200Vac-50Hz is supplied to the power supply terminal (20R1, 20SI, and 20T1) as control power supply.

3.1.1.2 TMdrive-P30

TMdrive-P30 requires the AC main power supply 1100Vac and control power supply 220/230Vac, 60Hz or 200Vac, 50Hz.

3.1.2 Grounding

Fig. 3.1.1 shows the recommended grounding circuit of TMdrive-30 and TMdrive-P30 with associated units. TMdrive-30 and TMdrive-P30 are normally used together and the common DC bus bar is used to connect between these two drive units. In this configuration, ground bus bar is also provided to connect between them. This equipment should be grounded in the following way:

- Connect the control ground from the ground bus bar (E_1) to the drive unit ground trunk line (E_D), at one point.
- Connect the main circuit neutral point and the motor ground to E2, and connect the ground from the converter to EHT, at one point.
- Wire the ED trunk line and EHT trunk line to the ground pole via the shortest route.
  (For the purpose of fixing the ground potential of the equipment for high frequency components.)
- When grounding a drive unit, use a ground pole executed with C-type grounding (100Ω or less ground resistance).
- When grounding the motor also, wire it to the ground pole via the shortest route.

Drive units can be installed in several ways, as shown in Table 3.1.1.

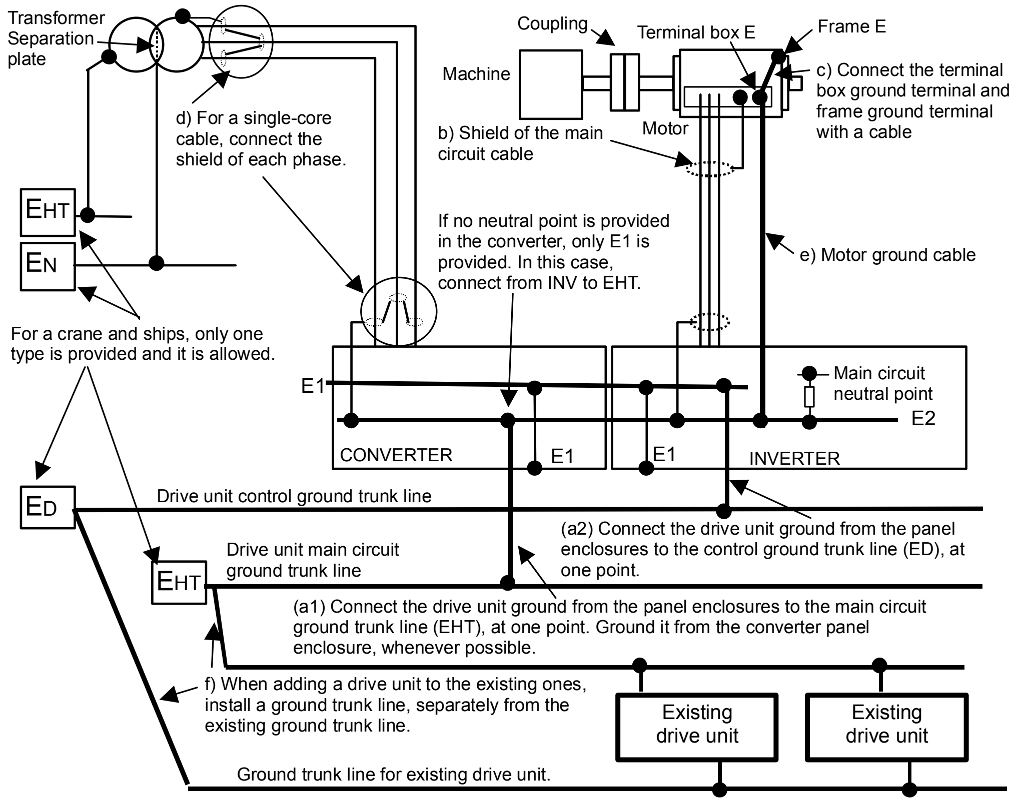


Fig. 3.1.1 Recommended Ground Circuit

⚠ CAUTION
When recommendation grounding construction is not constructed, a control equipment may incorrect-operate by the noise etc., or may not function normally.

Table 3.1.1 Grounding Types

Installation symbol	Installation construction class	Main types of equipment grounded	Remarks
E_A	Class A Under 10 Ω	Lightning rods	
E_{HT}	Class A Under 10 Ω	Special high-voltage frames	Use the shortest possible lines for the ground trunk
E_N	Class B Under 10 Ω	Transformer midpoints, insect protection plates	
E_{LT}	Class C Under 10 Ω	Low-voltage equipment grounding	
E_D	Class C Under 10 Ω	Drive units	Use the shortest possible lines for the ground trunk
E_{CG}	Class C Under 10 Ω	PLC, control system grounding	

3.2 Motor Interface (TMdrive-30)

When connecting to the motor, use a shielded cable and be sure to connect it to the grounding conductor on both the drive unit side and motor side.

3.2.1 One Motor

Connect the output terminals (U, V, W) of the equipment and motor terminals (R, S, T).
At this time, connect the output terminals of the equipment and motor terminals (U-R, V-S, W-T) as they are, irrespective of the rotation direction of the motor. The rotation direction of the motor can be set by parameters of the equipment. Do not change the cable interface to avoid confusions.

3.2.2 Multiple Motors

The sensor-less vector control, option, allows to control the parallel motor connections.
When multiple motors (n units) are connected in parallel, protection circuits are generally provided for each motor.

3.3 Speed Sensor Interface (TMdrive-30)

A pulse generator (PLG) or resolver is used as speed detector. At this time, note that the model of the XIO circuit board may vary depending on the type of sensor.
ARND-3120A: PLG or sensor-less vector control
ARND-3120B: Resolver or sensor-less vector control

3.3.1 PLG Interface (Differential Type)

The number of PLG output pulses [P/rev] is selected so that the PLG output pulse frequency at the maximum speed satisfies Equation 3.3.1. If it exceeds the specified range, the pulse may not be recognized, causing the control not to be done.

Equation 3.3.1 $3300\ [Hz] \leq (\text{rated motor speed})\ [min^{-1}] / 60 \times \text{PLG pulse count}\ [P/rev] \leq 100000[Hz]$

When using a PLG as speed sensor, pulse count of PLG output depends on the pulse count of the speed sensor and they become the same value (cannot be changed).

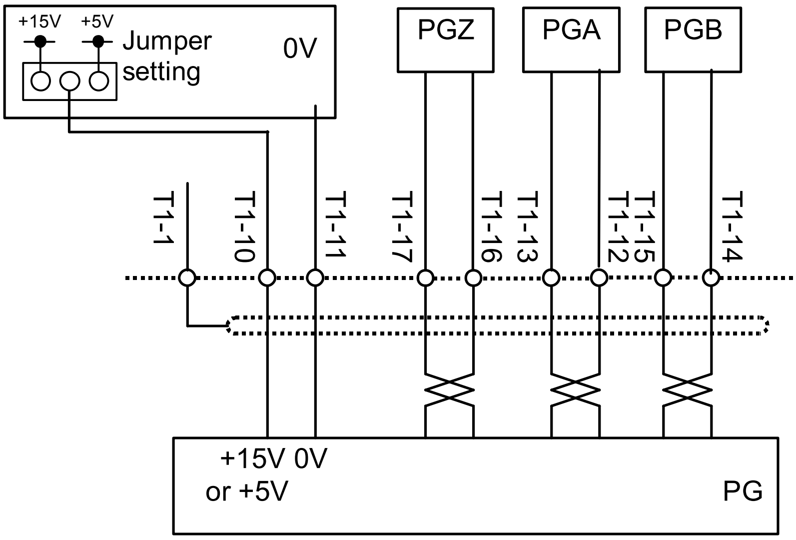


Fig. 3.3.1 PLG Interface

3.3.2 Resolver Interface

When the high-performance vector control (optional) is specified, a resolver is connected to this equipment. An optimal type is selected depending on the rated motor RPM from those shown in Table 3.3.1. (Either 1 kHz excitation or 4 kHz excitation)

Table 3.3.1 Resolver Types

Type	Rated RPM			
	1000 min-1 or less (4x) (1000 min-1 or more can not be used)		1000 min-1 or more (1x)	
	Model	Wiring diagram Fig. 3.3.2	Model	Wiring diagram Fig. 3.3.2
Frange type	TS2118N24E10N	a	TS2118N21E10N	b
Stationary type	TS2113N24E10NL	c	TS2113N21E10NL	d
Pan-cake type	TS2025N304E10	e	TS2025N301E10	e

Manufacturer: Tamagawa Seiki Co. Japan

The cable and wiring of the resolver may vary depending on the type of the resolver. For typical wiring, see Fig. 3.3.2. Always use the cables specified in Table 3.3.2. Additionally, the wiring is particularly vulnerable to noise. Always pay special attention so that the cables are separated sufficiently from the main circuit and wire bundling duct. The motor rotating direction and speed feedback polarity can be set using the parameters of the equipment. Therefore, never change the feedback polarity by changing the resolver wiring.

Table 3.3.3 shows the relationship between the equipment parameter setting and rotating direction.

Table 3.3.2 Specified Cables for Resolver

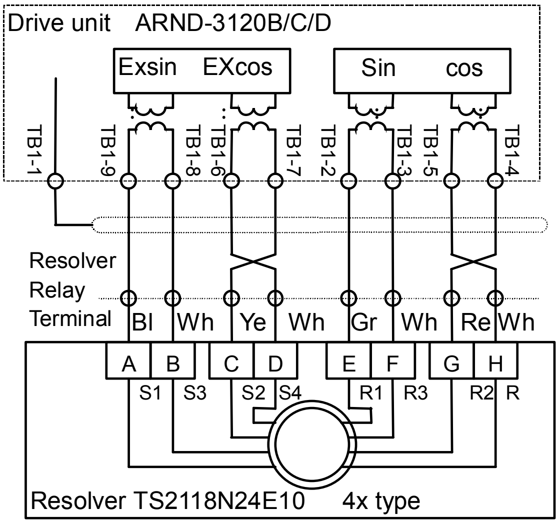
Manufacturer	Specification No.	Cable specifications
Showa Densen	WS82-1066	KMPEV-CU 4 P × 2 mm^2
Fujikura Densen	II-35122 (TPK88-1001)	IPEV-S (Cu) 4 P × 2 mm^2
Furukawa Denko	HT-880320 (TPK88-2001)	KPEV-S (Cu) 4 P × 2 mm^2
Mitsubishi Denko	BST-89112	SPEV (Cu) 4 P × 2 mm^2
Hitachi Densen	SP20-23768A	KPEV-S (Cu) 4 P × 2 mm^2
Sumitomo Denko	No. 3-23968	JKEV-S 4 P × 2 mm^2
Nishinihon Densen	DK-89144	JKPEV-SCT 4 P 2 mm^2

Table 3.3.3 Rotating Direction Settings

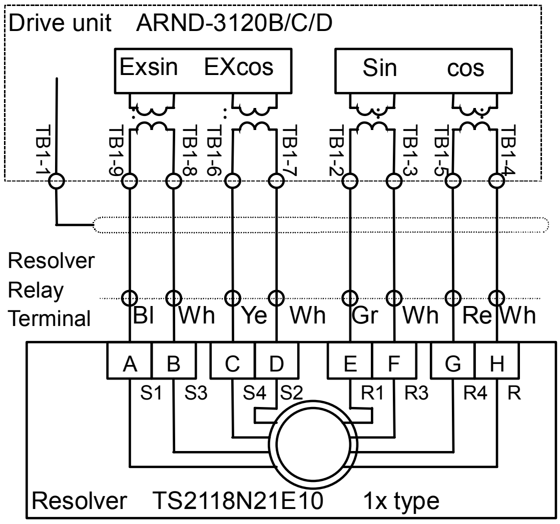
Rotating direction when the power is supplied to R -> S-> T of the motor in that order	CW		CCW*1 (for reference)	
$FLG_WVU	0		1	
Rotating direction when the positive speed reference is applied	CW	CCW	CW	CCW
Polarity of $CS_MOTOR_RPM	+	-	+	-

*1)CCW rotation can be obtained by supplying power in the order of R->S->T with wiring connection between equipment and motor in reverse but do not use this way to avoid confusion.
CW (Clockwise): Clockwise viewed from the opposite side of motor load
CCW (Counter-clockwise): Counter-clockwise viewed from the opposite side of motor load

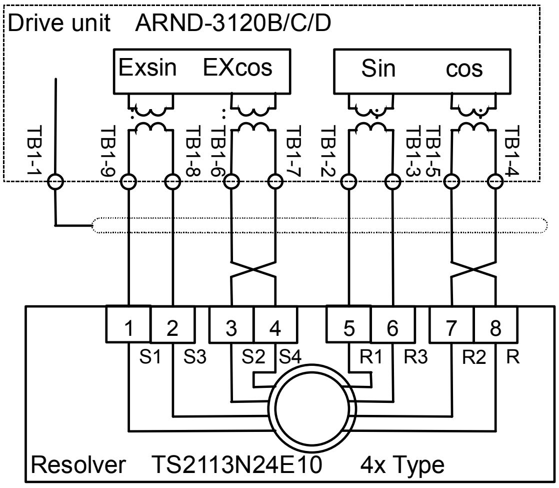
When the directional setting is changed, make sure to initialize the system (turn on and then off the MCCB “CONTROL”) to make the new setting effective.



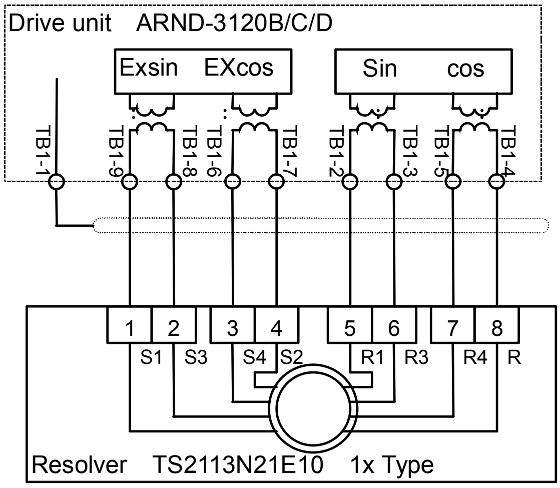
a) TS2118 series (flange type) 4x



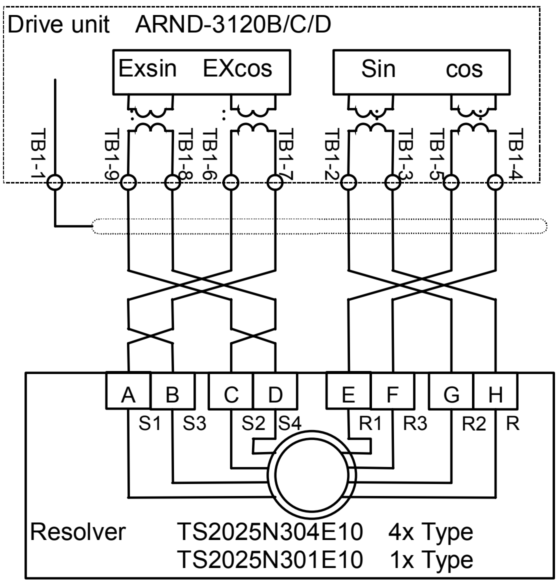
b) TS2118 series (flange type) 1x



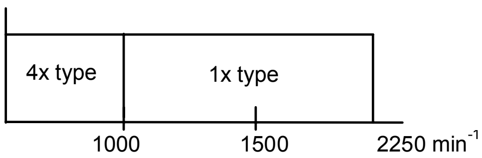
c) TS2113 series (stationary type) 4x



d) TS2113 series (stationary type) 1x



e) TS2025 Type (Pan-cake type)



f) Selection standard of 1x and 4x

Fig. 3.3.2 Type and Wiring of Resolvers

3.3.3 Sensor-less Vector Control

In this control, no speed sensors are required. Either of the following two XIO circuit board types is used.
ARND-3120A: PLG or sensor-less control
ARND-3120B: Resolver or sensor-less control

The following cautions must be observed when using the sensor-less vector control.

(1) PLG pulse signals obtained using the vector control with sensor cannot be obtained with sensor-less vector control.

(2) The speed feedback signal obtained by operations of sensor-less vector control shows the specified accuracy only when the inverter is supplying current to the motor. Therefore, if the motor is made to a coast stop or when it is running by outside force, the speed feedback signal does not show correct values.

(3) Do not use the inverter in an application where the inverter is being started in the direction opposite the motor that is currently running.

(4) When the motor is replaced, readjustment is required (except the case when the replaced motor is the same type and form as before.)

(5) When field weakening control is used, rapid acceleration/deceleration such as current limit acceleration/deceleration is not allowed.

When sensor-less vector control is used to drive multiple motors in parallel, be careful about the following as well as above.

(1) A twin drive inverter cannot balance the current between bankers and thus it cannot be used in a system to drive multiple motors in parallel. (For example, it is not possible to drive 20 motors with 10 motors in each bank.)

(2) Motors running in parallel must have the same rating and the load devices of the motors must have the same moment of inertia (GD^2). If different rating motors are included or the load condition changes continuously (GD^2 is different), parallel operation is not possible.

(3) When motors are running at a constant speed of less than 10% and the load devices of the motors are unbalanced, motors with no load or light load receive over excitation and thus require overheat measures.

(4) Stopping torque (torque required for motor + 50%) must be secured. (For example, when load torque 200% is required, the motor must have 250% or more torque output.)

(5) Variation in the number of motors while running can be up to 50% at one time.

(6) When connecting an additional motor to the running inverter, design sequence so that a motor is added only when the inverter output voltage is at 30% (≈ operation speed at 30%) or less. In this case, the number of units connectable at the same time to the inverter is one unit or within 10% of the total number of motors.

(7) The minimum speed is 1.8 Hz. A continuous constant speed operation or jog run at a speed less than 1.8Hz cannot be made.

(8) APC (position control) has limitations on how to stop the motor. For example, with a speed of 5% or less, a coast stop or DC braking (DB) is possible but this cannot be applied in an application where targeted stopped position accuracy cannot be obtained unless the speed is controlled and reduced to 5% or less.

3.3.4 Speed Pulse Signal Output (Single end type)

When the resolver or PLG is used, the speed signal can be output as pulse signal. (These pulse signals cannot be output in the sensor-less vector control.) Fig. 3.3.3 shows the PLG pulse output circuit. The power for pulses is supplied from an external power supply. Prepare this external power supply in a range of 15 V to 48 V.

The PLG pulse output consists of two phases, PGA and PGB. When the motor rotates in the normal direction, the pulse has 90°-advance phase. The pulse signals (power supply level supplied from outside) are insulated from the control power supply in the equipment through a photo-coupler.

The pulse output count per motor revolution can be set as follows. At this time, make the settings so that the pulse count at 100% speed does not exceed 10 kHz. If it exceeds 10 kHz, this may cause the pulses not to be transmitted.

(1) 1x type resolver is used.
$CS_RES_TYPE = 1
$CS_PGOUT: Any of 64, 128, 256, 512, and 1024 is set.

<Example> When the 100%-speed is 1800 min^{-1}.
$CS_PGOUT is determined so that (1800/60) x $CS_PGOUT < 10000 is satisfied.
$CS_PGOUT < 10000/(1800/60) = 333
Therefore, $CS_PGOUT = 256.

(2) 4x type resolver is used.
$CS_RES_TYPE = 4
$CS_PGOUT: Any of 256, 512, 1024, 2048, and 4096 is set.

<Example> When the 100%-speed is 400 min^{-1}.
$CS_PGOUT is determined so that (400/60) x $CS_PGOUT <10000 is satisfied.
$CS_PG_OUT < 10000/(400/60) = 1500
Therefore, $CS_PGOUT = 1024.

(3) When PLG is used.
$CS_RES_TYPE = 1 (Always set this value to "1".)
$CS_PGOUT = 0 (Always set this value to "0".)

The output pulse count is the same as that input.
If the above setting is changed, always initialize the equipment (turn off the control power MCCB "CONTROL", and turn it on again) to make the newly set data valid.

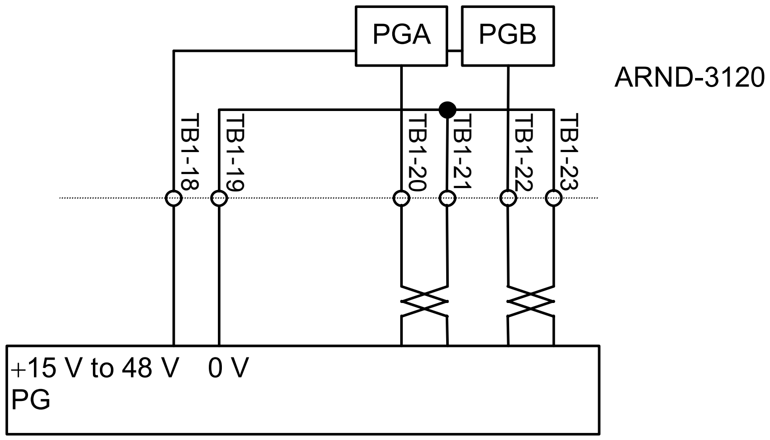


Fig. 3.3.3 Speed Pulse Signal Output Circuit

3.4 Serial Transmission

In addition to P-I/O, this drive equipment also supports serial data transmission using a transmission unit. The TMdrive-10 can be set up to use one, the other, or both of these techniques. The serial data transmission unit provides an interface with upstream programmable controllers (PLC units).

The serial data transmission unit provides two types of transmission: scan transmission and message transmission, although it can be used for scan transmission only depending on the system specifications or transmission type.

In addition, in this book, the case where drive equipment receives from external equipments, such as PLC, is considered as "reception" or a "input", and the case where it transmits to external equipment from drive equipment is considered as "transmission" or a "output".

(1) Scan transmission
This transmission system transmits data at specified intervals (at regular time). This system is used to input and output the speed and sequence signals between the drive unit and PLC.

(2) Message transmission
This transmission system transmits data among specified stations at irregular time. This system is applicable to transmission of a lot of data, such as trace-back data if a fault occurs. This transmission corresponds by TOSLINE-S20 transmission and ISBus transmission. In TOSLINE-S20 transmission, it is an option by system specification.

(3) Transmission unit
Unit of transmission data is called “word”. 1 word is 16 bits.
1 word of the number of scan memory word is 16 bits.

See 70 page to transmission data format.

3.4.1 Transmission Types

Depending on the scan transmission speed and the number of stations, two types of transmission systems are available as shown in Table 3.4.1 to Table 3.4.4. An optimal transmission type suitable for the user’s application is selected.

Table 3.4.1 Overview of TOSLINE-S20

	Standard version	High speed version
Maximum number of stations	PLC station: 1 unit Drive station: 63 units (ASC is used.)	PLC station: 1 unit Drive station: 4 units
Scan memory words	Maximum 1024 words 16 words send and receive/unit	Maximum 128 words 16 words send and receive/unit
Transmission speed of scan transmission	64 stations × 16 words Interval: 25 ms	4 drive units × 16 words Interval: 2 ms
	8 stations × 16 words Interval: 4 ms	2 drive units × 16 words Interval: 1 ms
Frame size of message transmission	544 bytes	74 bytes

Table 3.4.2 Overview of ISBus

	ISBus
Maximum number of stations	Master or drive station: 32 units
Scan memory words	10 words send and receive/unit
Transmission speed of scan transmission	Maximum 5Mbps
Frame size of message transmission	128 bytes

Table 3.4.3 Overview of DeviceNet

	DeviceNet
Maximum number of stations	Master or drive station: 64 units
Scan memory words	4 words send and receive /unit, 4 words send and 10 words receive /unit
Transmission speed of scan transmission	125 kbps, 256 kbps, 500 kbps
Frame size of message transmission	Not supported

Table 3.4.4 Overview of PROFIBUS

	PROFIBUS Cable type A
Maximum number of stations	Master or drive station: 32 units (with repeater) Master or drive station: 99 units (without repeater)
Scan memory words	6 words send and receive /unit
Transmission speed of scan transmission	9.6 kbps ~ 12 Mbps (Set by Master side)
Frame size of message transmission	Not supported

3.4.2 TOSLINE-S20 Specifications

Two types of TOSLINE-S20 are available depending on the connector type. As shown below, TOSLINE-S20 with the standard specifications uses F07-type optical connector. Table 3.4.5 shows the standard specifications.

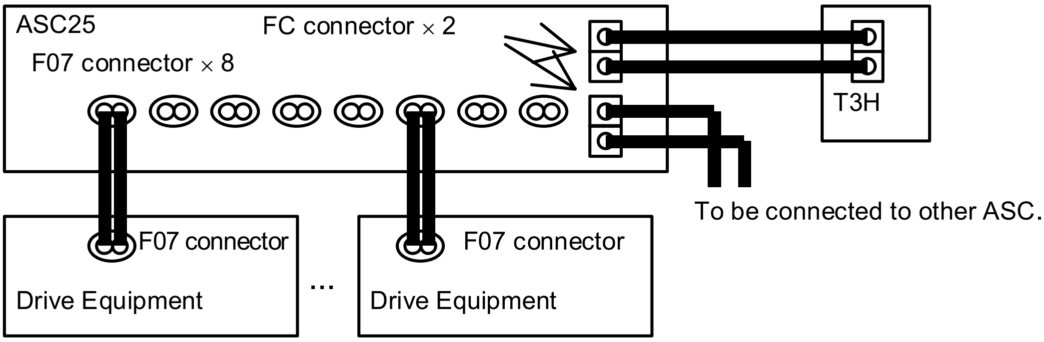
Table 3.4.5 TOSLINE-S20 Hardware Specifications

Item	TOSLINE-S20 transmission board type	
	ARND-8213A, 8217A	ARND-8110A, 8213D, 8217D
Connector type	F07 type optical connector	FC type optical connector
Fiber specification*1)	HPCF cable 200/230 μm (Core diameter/Clad diameter)	Silica optical cable GI model 50/125 μm (Core diameter/Clad diameter)
Transmission distance	Maximum distance between stations: 1 km Overall length: 10 km or less	Same as left
Applicable ASC model	ASC25 SASC25*US FC connector: 2 ch F07 connector: 8 ch	ASC22 SASC22*US FC connector: 10 ch

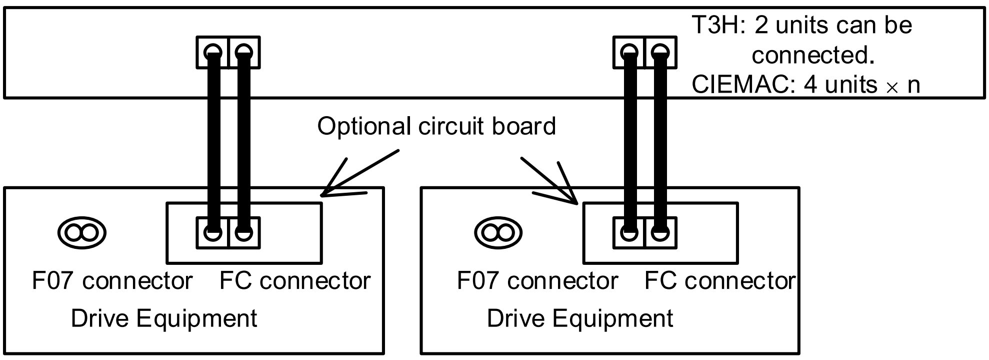
*1)The cable with which wavelength specification differs cannot be used.
Use ASC25(Active Star Coupler) to connect this standard specification TOSLINE-S20 and PLC.

3.4.2.1 TOSLINE-S20 Connections

The connections may vary depending on the type of connector as shown in Fig. 3.4.1.



a) Connections of F07 connector



b) Connections of FC connector

Fig. 3.4.1 Examples of TOSLINE-S20 Connections

3.4.2.2 Scan Transmission

This transmission system transmits data at specified intervals (at regular time). The drive unit contains inputs and outputs. The input is command inputs, such as speed reference and sequence signals from the PLC.

The output is used to transmit actual speed and current values from the drive unit to host control or monitor units, such as PLC. The scan transmission system uses a common memory system, in which data written on each station is shared by all stations.

▪Common Memory System

Data is exchanged between the microcomputer of the drive unit and TOSLINE-S20 though dual-port RAM (DPRAM). For details, see Fig. 3.4.2.

The microcomputer that controls the drive equipment writes (outputs) send data at a specified address of the DPRAM in the TOSLINE-S20 at specified intervals (1 ms to 25 ms, this may vary depending on the type of system).

Additionally, this microcomputer reads (inputs) data at a specified address of the DPRAM. Addresses, at which each station writes data, are allocated (by each station) so that they are not duplicated.

The transmission system of the TOSLINE-S20 transmits data on this DPRAM to all stations at specified intervals (this interval may vary depending on the number of stations connected). The data is then written to the DPRAM on each station.

The same data on this DPRAM is then made on all stations. Therefore, this system is called “common memory”. Use of the scan transmission makes it possible to transmit data between drive units (called transmission between drive units), as well as data transmission between the drive unit and PLC.

▪Number of Transmission Words

The maximum number of transmission words which one station (drive equipment) treats is the following number of words, when using transmission between drives. Smaller value than this is also available.

Data which drive equipment receives from PLC:	6 words
Data which drive equipment receives from other drive equipments:	4 words
Data which drive equipment outputs:	10 words

In case that transmission between drives is not used, the maximum number of transmission words is the following number of words. Smaller value than this is also available.

Data which drive equipment receives from PLC:	10 words
Data which drive equipment outputs::	10 words

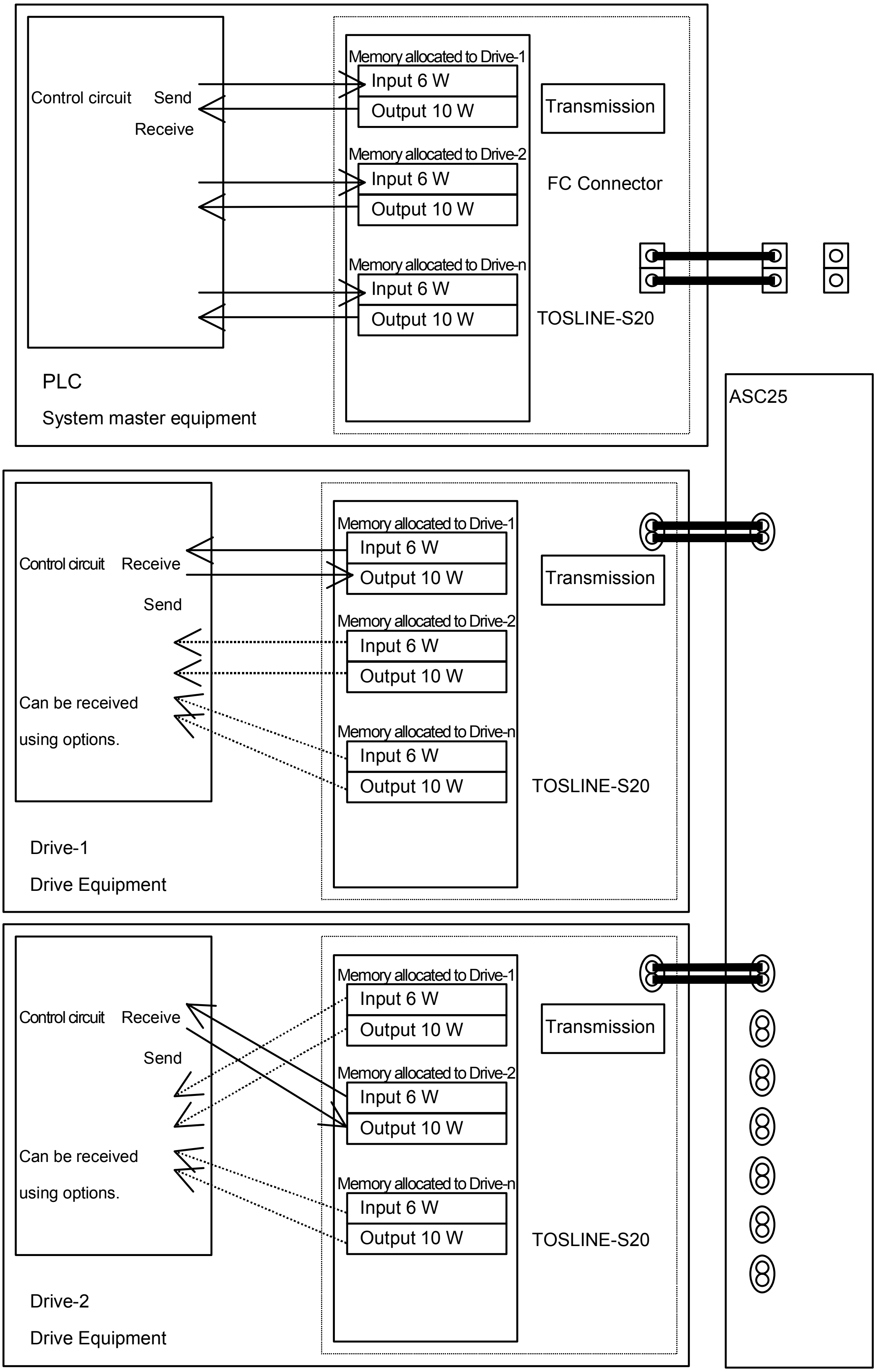


Fig. 3.4.2 Description of Common Memory

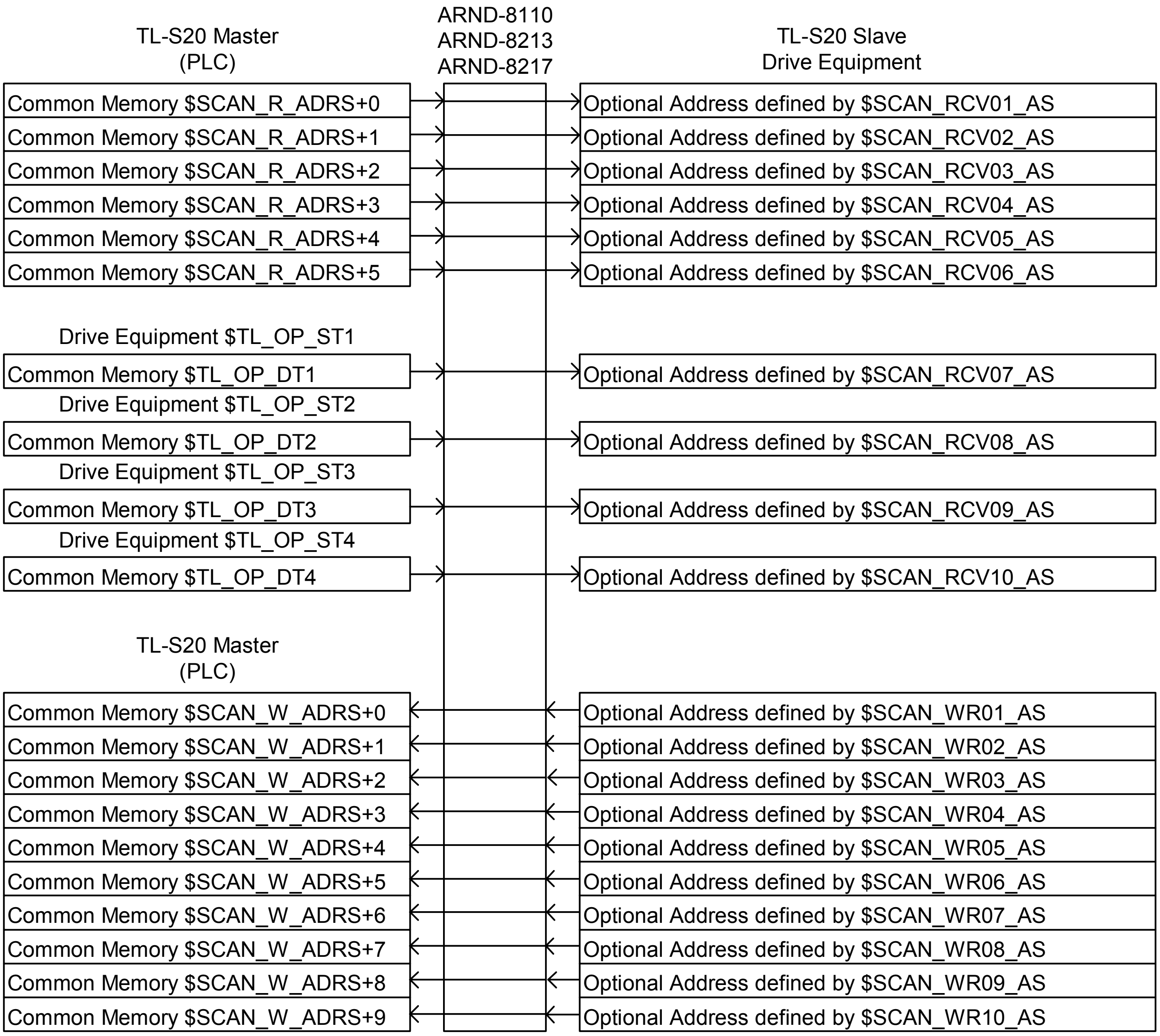


Fig. 3.4.3 TOSLINE-S20 Transmission (Using transmission between drive units)

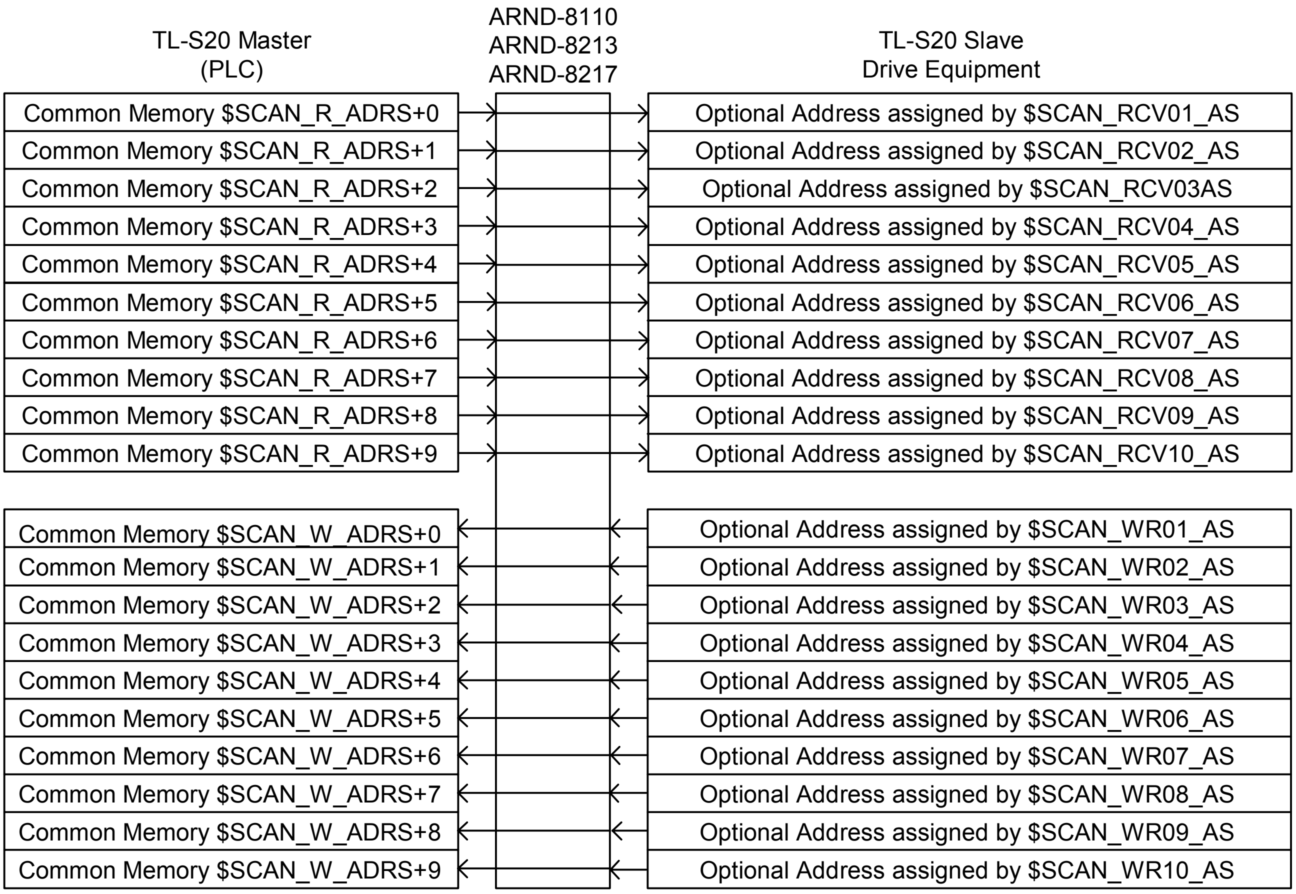


Fig. 3.4.4 TOSLINE-S20 Transmission (Using transmission between drive units)

Table 3.4.6 shows the parameter settings. Since these settings may greatly affect operation of the entire system, the settings must be determined by taking the configuration of the entire PLC system into consideration. For details of settings, see the instruction manual for parameters and actually set data.

Table 3.4.6 Transmission Parameter Settings

	Data name	Application	Setting value example	Explanation
$COMM_TYPE		Transmission mode selection	0000 H	Not used
			0400 H	TL-S20 standard version transmission (ARND-8110)
			2400 H	TL-S20 high-speed version transmission (ARND-8110), or PROFIBUS transmission (ARND-8130)
			0020 H	TL-S20 standard version transmission (ARND-8217)
			2020 H	TL-S20 high-speed version transmission (ARND-8217)
$TL_SELF_NO		Own station No.	0	Transmission not used
			1 to 64	TL-S20 standard version transmission
			1 to 5	TL-S20 high-speed version transmission
$TL_PC_NO		PLC station No.	0	Transmission not used
			Other	Master station number
$TL_CYC_TIME		Cycle time	3 to 31	TL-S20 standard version transmission Transmission cycle target time (ms)
			21	TL-S20 high-speed version transmission
Receiving word data	$SCAN_R_SIZE	Number of receive words setting	6	Not using transmission between drive units
			10	Using transmission between drive units
	$SCAN_R_ADRS	Start address of receive data	0	Transmission not used
			0 to 1023	TL-S20 standard version transmission
			0 to 127	TL-S20 high-speed version transmission
	$SCAN_RCV01_AS	Receiving address 1	SERSEQDATA1, SERSEQDATA2	Sequence signal (input) * Usage is fixed
	$SCAN_RCV02_AS to $SCAN_RCV06_AS	Receiving address 2 to 6	Specifies data to store received data	When $SCAN_R_SIZE = 6 is set, 5 data can be set freely. When not used, Enter “DUST”.
	$SCAN_RCV07_AS to $SCAN_RCV10_AS	Receiving address 7 to 10	Specifies data to store received data	Used to transmit data between drives Data address of the opponent is specified as $TL_OP_ST1 to 4 and $TL_OP_DT1 to 4 When not used, Enter “DUST”.
Transmitting word data	$SCAN_W_SIZE	Number of send words setting	10	10 words are sent by scan transmission.
	$SCAN_W_ADRS	Start address of send data	0	Transmission not used
			0 to 1023	TL-S20 standard version transmission
			0 to 127	TL-S20 high-speed transmission
	$SCAN_WR01_AS	Sending address 1	SSEQ_OUT1, SSEQ_OUT2	Sequence signal (output) * Usage is fixed
	$SCAN_WR02_AS to $SCAN_WR10_AS	Sending address 2 to 10	Specifies data to store received data	When $SCAN_W_SIZE = 10 is set, 9 data can be set freely. When not used, Enter “DUST”.
Drive-to-drive transmission	$TL_OP_ST1 to $TL_OP_ST4	Drive-to-Drive transmission opponent station number	0	Transmission not used
			1 to 64	TL-S20 standard version transmission
			1 to 5	TL-S20 high-speed transmission
	$TL_OP_DT1 to $TL_OP_DT4	Drive-to-Drive transmission opponent word data address	Specifies data to store received data	4 data can be set freely. When not used, Enter “DUST”.

3.4.3 ISBus Transmission Specifications

ISBus hardware specifications are shown in below.

Table 3.4.7 ISBus Hardware Specifications

Item	ISBus transmission board type	
	ARND-8204A	
Connector type	RJ45 Connector	
Cable specification	Shielded twisted pair cable	
Bus scan time	Number of node	Bus scan time [ms]
	2 ~ 4	1
	5 ~ 8	2
	6 ~ 16	4
	17 ~ 32	8

3.4.3.1 ISBus Connection

Example of connection is shown in Fig. 3.4.5.

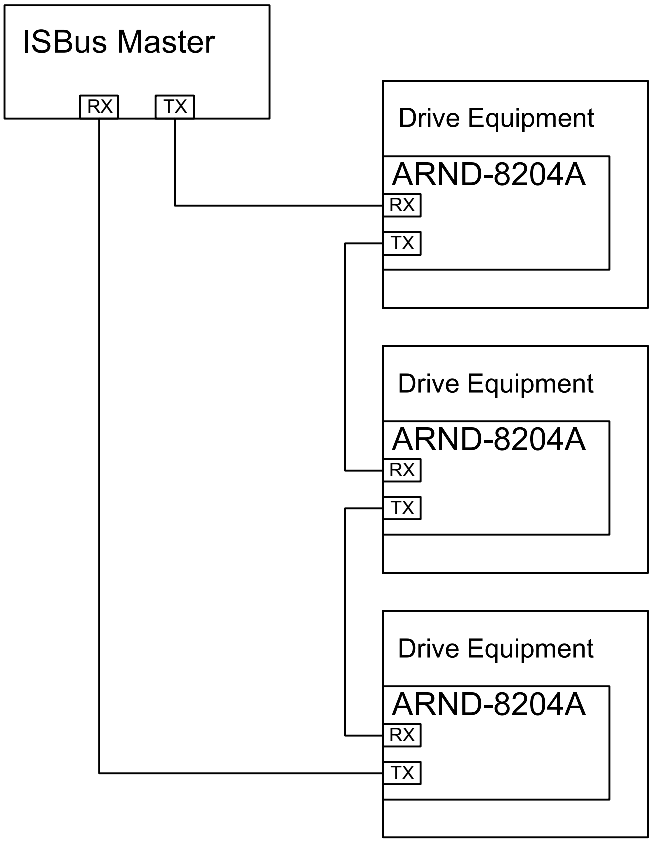


Fig. 3.4.5 Examples of ISBus Connection

3.4.3.2 Scan Transmission

This transmission system transmits data at specified intervals (at regular time).

There are inputs and outputs as drive equipment. Inputs are command input of the speed reference and the sequence signal from PLC etc. Outputs are used for transmission of the actual value of speed and current, etc. from drive equipment to control / surveillance apparatus of upper side, such as PLC.

- The Original Protocol of RS485 Driver

The communication protocol of ISBus is using the original protocol of RS485 driver.

- The Number of Transmission Words

The number of send and receive transmission words which one station (drive equipment) treats are 10 words.

Sending and receiving contents are shown in Fig. 3.4.6 and Fig. 3.4.7. As for the first word, sending and receiving perform bit transmission inside a transmission board. Although transmission data in ISBus master (PLC) is 32 bits, these are divided into 16 bits and arranged perpendicularly in Fig. 3.4.6 and Fig. 3.4.7.

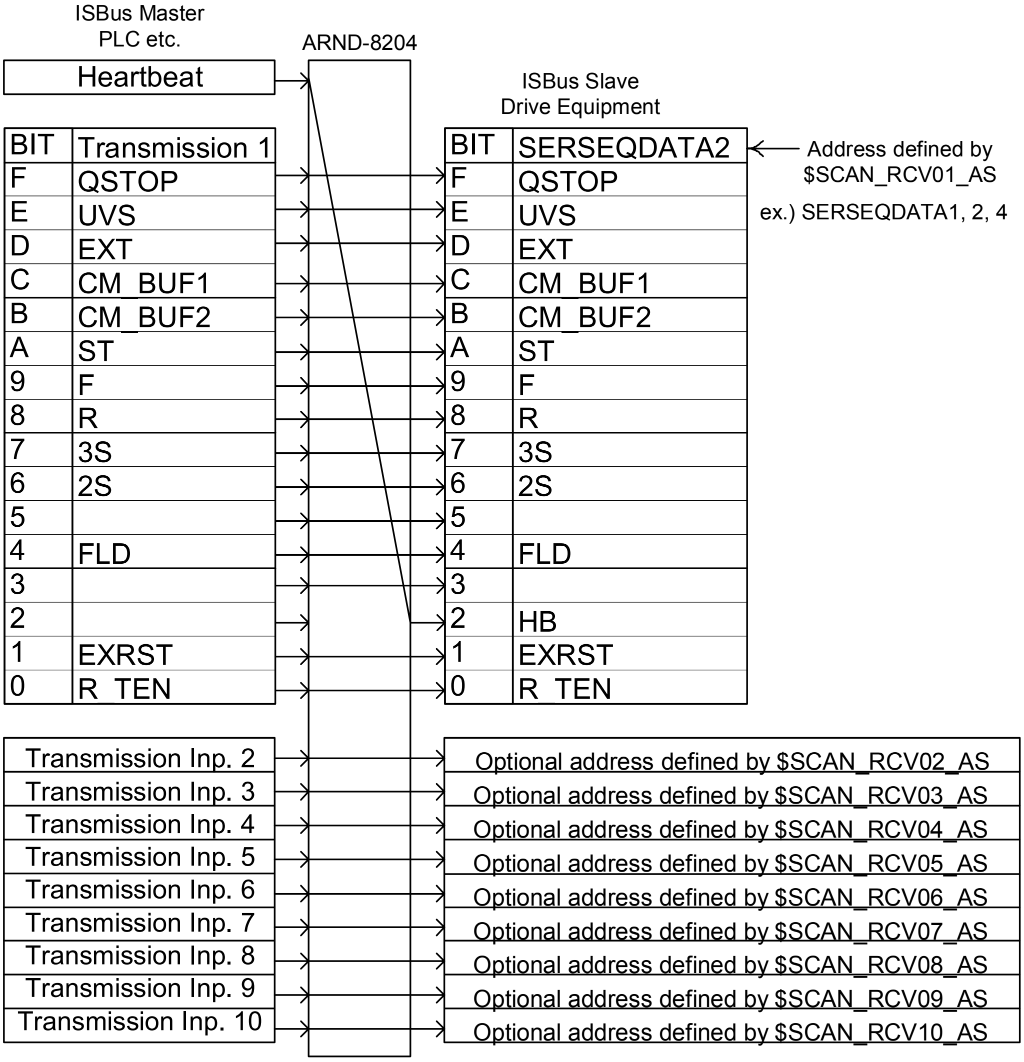


Fig. 3.4.6 ISBus (Receive)

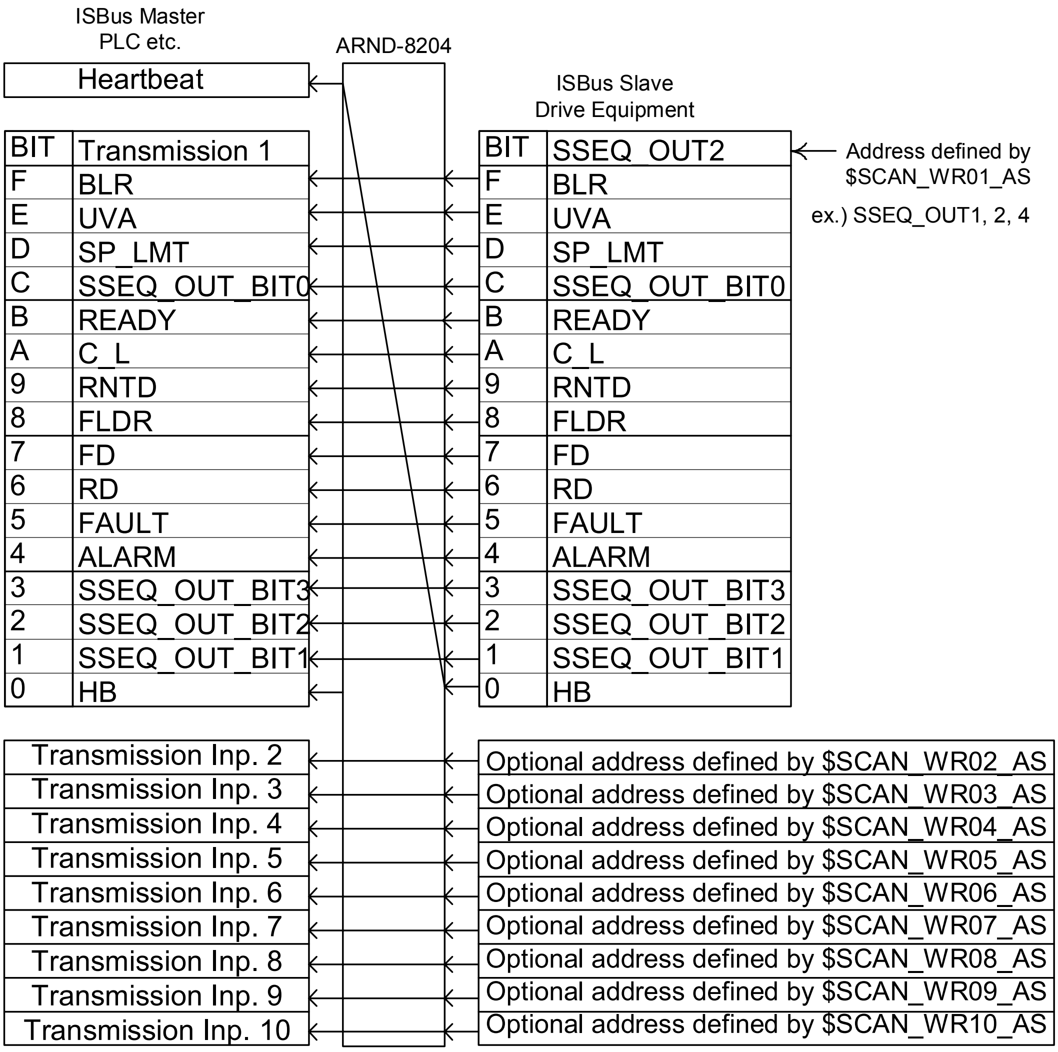


Fig. 3.4.7 ISBus (Send)

Table 3.4.8 shows the parameter settings. Since these settings may greatly affect operation of the entire system, the settings must be determined by taking the configuration of the entire PLC system into consideration. For details of settings, see the instruction manual for parameters and actually set data.

Table 3.4.8 ISBus Transmission Parameter Settings

Class	Data name	Application	Setting value example	Explanation
Common	$COMM_TYPE	Transmission mode selection	0040 H	ISBus Transmission
	$FLG_DSCAN	Transmission between drive units	0	Do not use
	$TL_SELF_NO	Own station No.	2	Fixed
	$TL_PC_NO	PLC station No.	1	Fixed
	$TL_CYC_TIME	Cycle time	21	Fixed (Auto)
Receiving word data	$SCAN_R_SIZE	Number of receive words setting	10	Fixed
	$SCAN_R_ADRS	Start address of receive data	16	Fixed
	$SCAN_RCV01_AS	Receiving address 1	SERSEQDATA2	Sequence signal (input) (Set sequence signal (input) of Bit 2=HB)
	$SCAN_RCV02_AS ~ $SCAN_RCV10_AS	Receiving address 2 to 10	Specifies data to store received data	Ex.) SP_REF1 When not used, set "DUST".
Sending word data	$SCAN_W_SIZE	Number of send words setting	10	Fixed
	$SCAN_W_ADRS	Start address of send data	0	Fixed
	$SCAN_WR01_AS	Sending address 1	SSEQ_OUT2	Sequence signal (output) (Set sequence signal (output) of Bit 0=HB)
	$SCAN_WR02_AS ~ $SCAN_WR10_AS	Sending address 2 to 10	Specifies data to store received data	Ex.) SP_F_OUT When not used, set "DUST".
Drive-to-drive transmission	$TL_OP_ST1 ~ $TL_OP_ST4	Drive-to-Drive transmission opponent station number	0	Do not use
	$TL_OP_DT1 ~ $TL_OP_DT4	Drive-to-Drive transmission opponent word data address	DUST	Do not use

3.4.4 DeviceNet Transmission Specifications

DeviceNet hardware specifications are shown in below.

Table 3.4.9 DeviceNet Hardware Specifications

<table>
<tr><th rowspan="2">Item</th><th colspan="3">DeviceNet transmission board type</th></tr>
<tr><th colspan="3">ARND-8127A</th></tr>
<tr><td>Connector type</td><td colspan="3">Plug-in connector (open type)</td></tr>
<tr><td>Cable specification</td><td colspan="3">Trunk line
One pair of twisted signal (#18): Blue/White
One pair of twisted power source (#15): Black/Red
Foil/stitch shielded drain wire (#18): Open wire
Drop line
One pair of twisted signal (#24): Blue/White
One pair of twisted power source (#22): Black/Red
Foil/stitch shielded drain wire (#22): Open wire</td></tr>
<tr><td rowspan="5">Transmission distance</td><td colspan="3">Depending on transmission speed</td></tr>
<tr><td>Transmission speed [kbps]</td><td>Maximum trunk cable length [m]</td><td>Maximum drop cable length [m]</td></tr>
<tr><td>125</td><td>500 m</td><td>100 m</td></tr>
<tr><td>250</td><td>250 m</td><td>100 m</td></tr>
<tr><td>500</td><td>100 m</td><td>100 m</td></tr>
<tr><td>DeviceNet power supply</td><td colspan="3">24 V±1%</td></tr>
</table>

3.4.4.1 DeviceNet Connection

Example of connection is shown in Fig. 3.4.8.

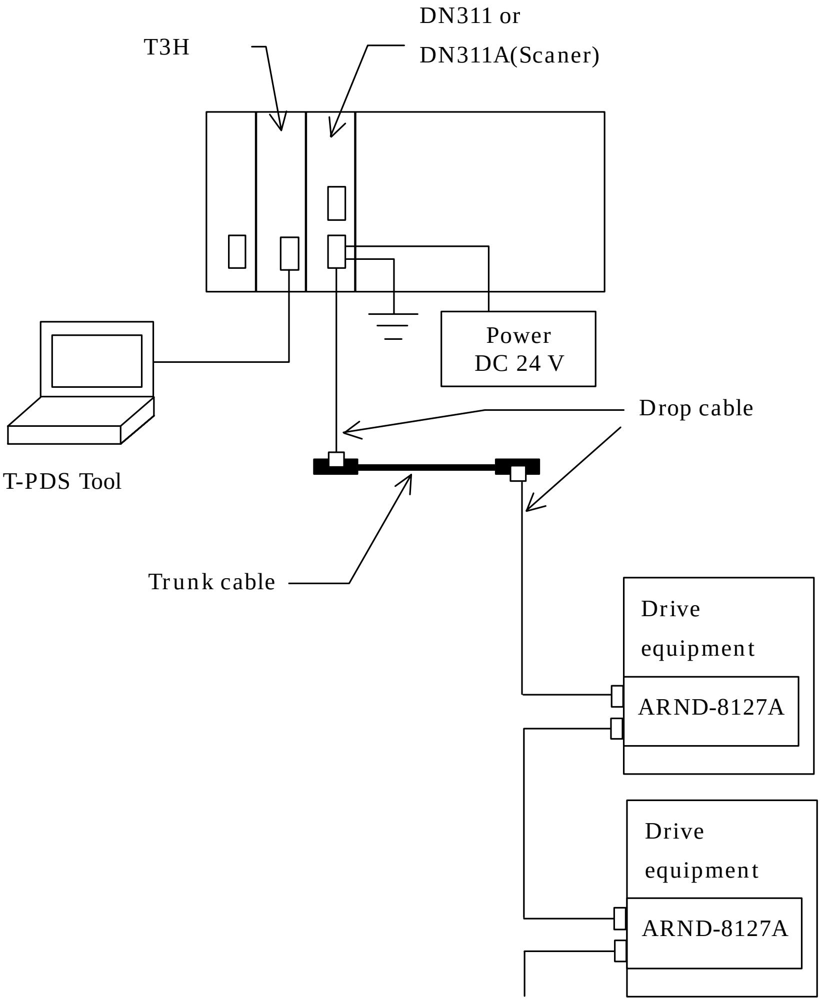


Fig. 3.4.8 Examples of DeviceNet Connection

3.4.4.2 Scan Transmission

This transmission system transmits data at specified intervals (at regular time).

There are inputs and outputs as drive equipment. Inputs are command input of the speed reference and the sequence signal from PLC etc. Outputs are used for transmission of the actual value of speed and current, etc. from drive equipment to control / surveillance apparatus of upper side, such as PLC.

- CAN

The communication protocol of DeviceNet is using a controller area network (CAN).

- The Number of Transmission Words

The numbers of transmission words which one station (drive equipment) treats are 4 words receiving / 4 words sending (4W/4W mode), or 4 words receiving / 10 words sending (4W/10W mode).

- DeviceNet Transmission Mode

The transmission mode of DeviceNet is 4W/4W mode or 4W/10W mode. The transmission mode is set up by $SCAN_WR_SIZE.

The sending and receiving contents in the case of the 4W/4W mode are shown in Fig. 3.4.9 and Fig. 3.4.10. The contents of transmission of DeviceNet master (PLC) is based on DeviceNet specifications Volume II Release 1.2 Instance 23 and 73.

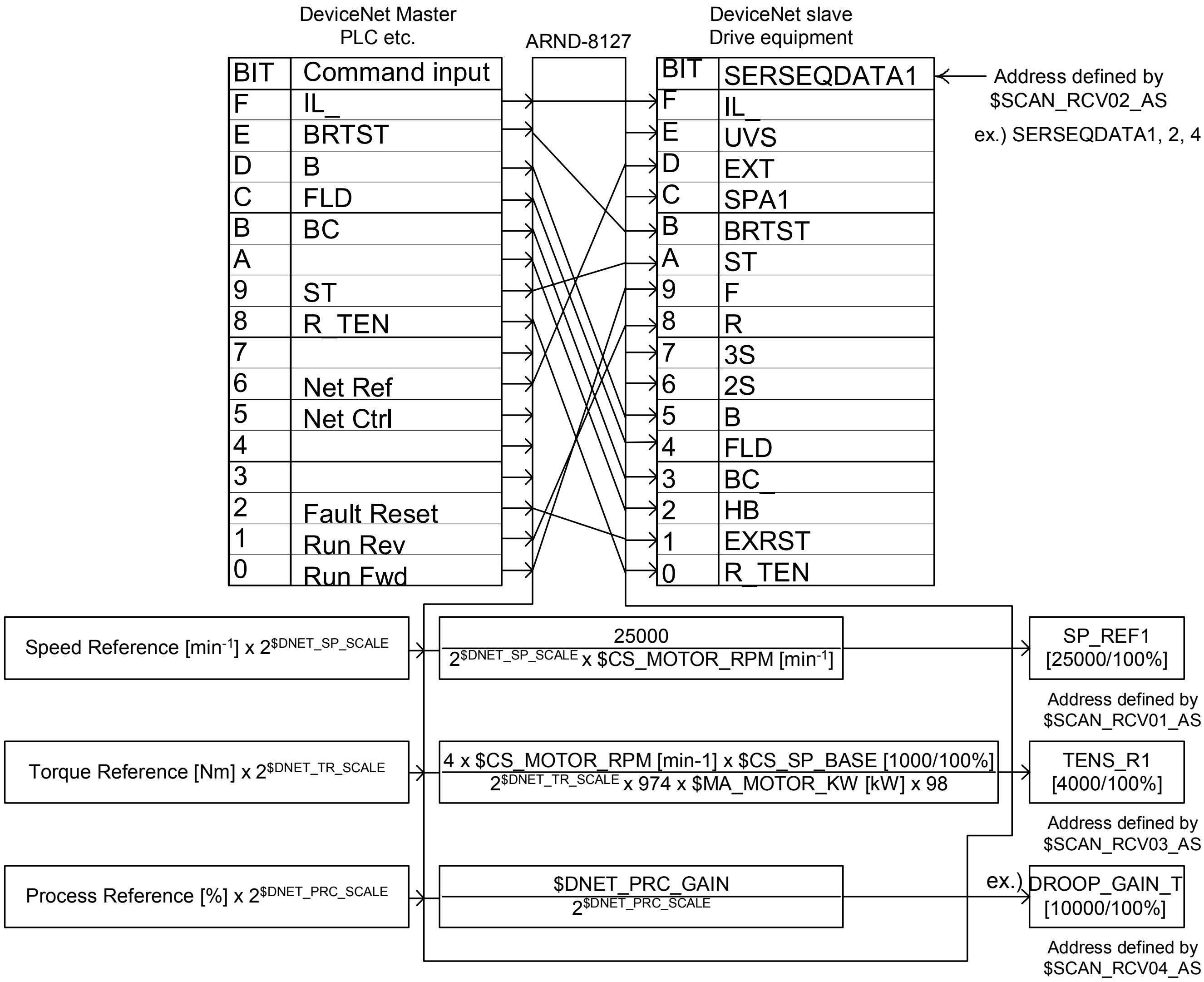


Fig. 3.4.9 DeviceNet 4W/4W Mode (Receive)

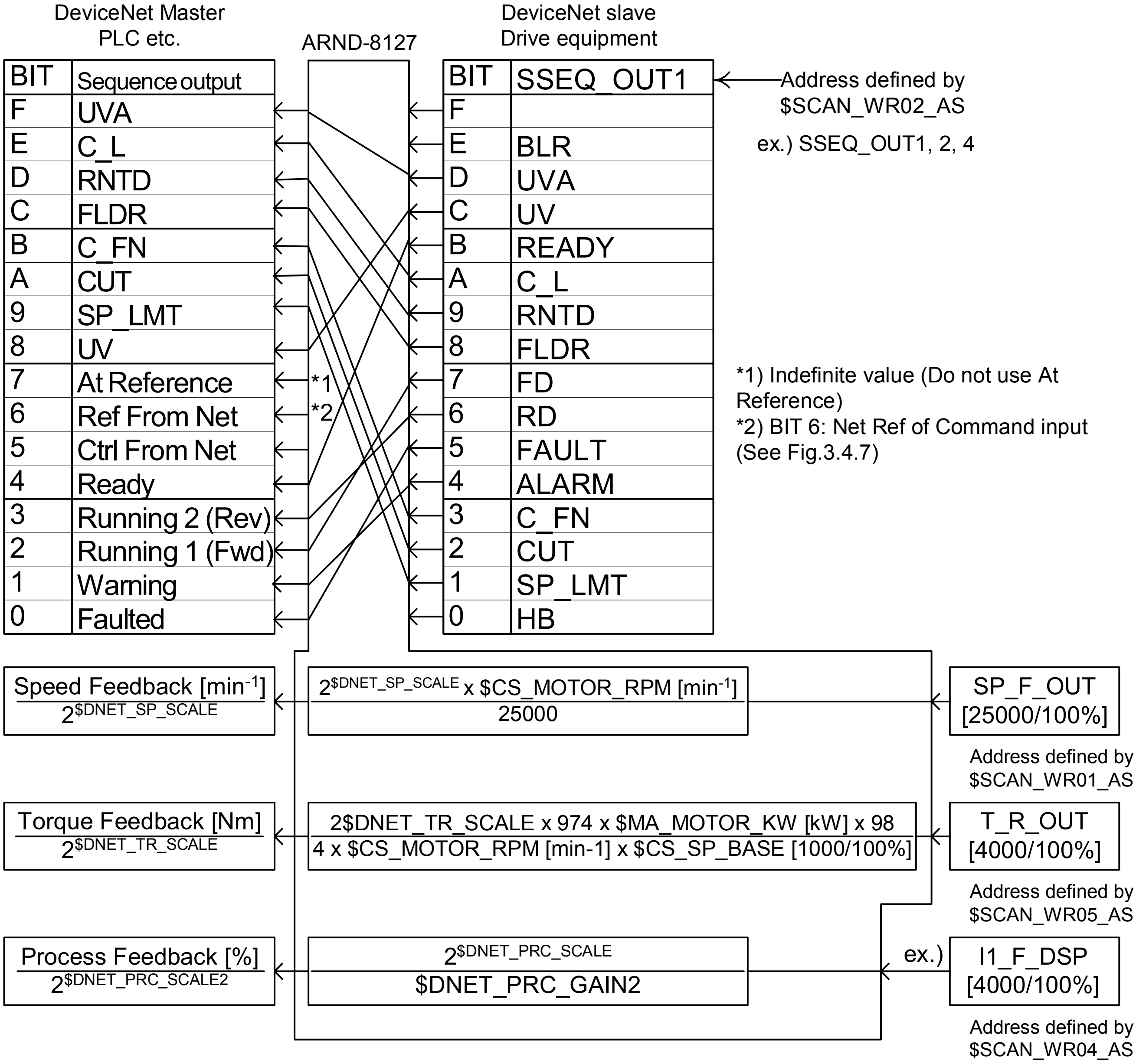


Fig. 3.4.10 DeviceNet 4W/4W Mode (Send)

The sending and receiving contents in the case of 4W/10W mode are shown in Fig. 3.4.11 and Fig. 3.4.12. As for the first word, sending and receiving perform bit transmission inside a transmission board. The contents of transmission of DeviceNet master (PLC) are based on DeviceNet specification Volume II Release 1.2 Instance 23 and 73.

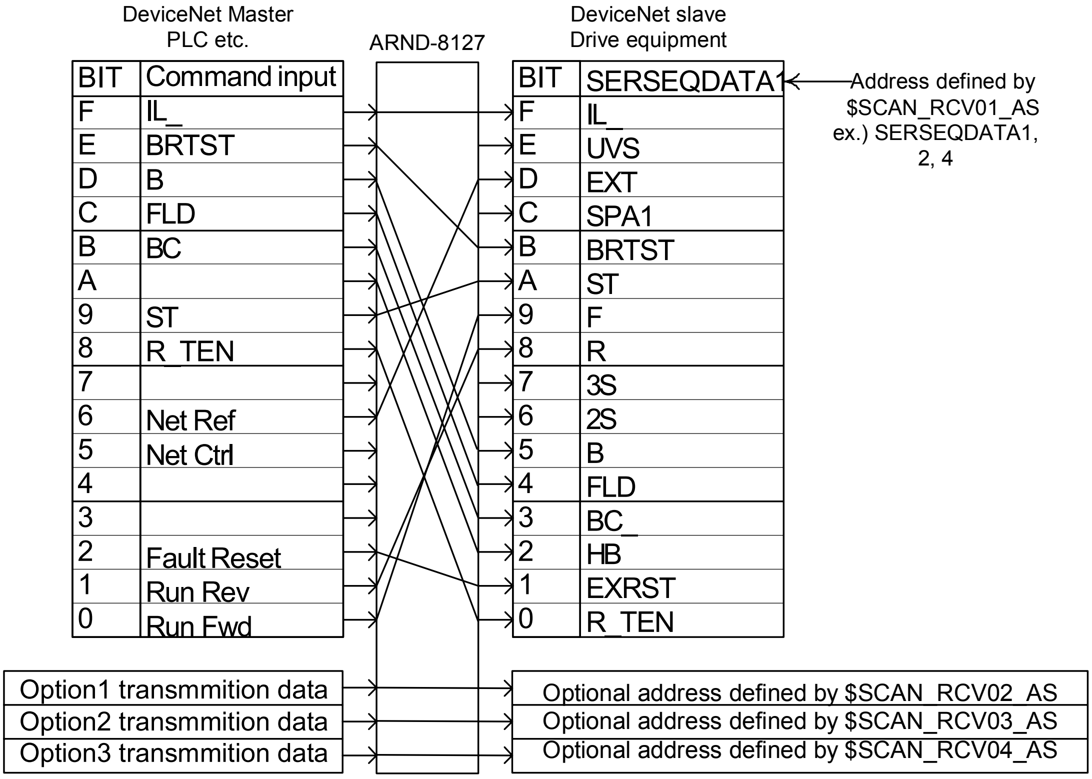


Fig. 3.4.11 DeviceNet 4W/10W Mode (Receive)

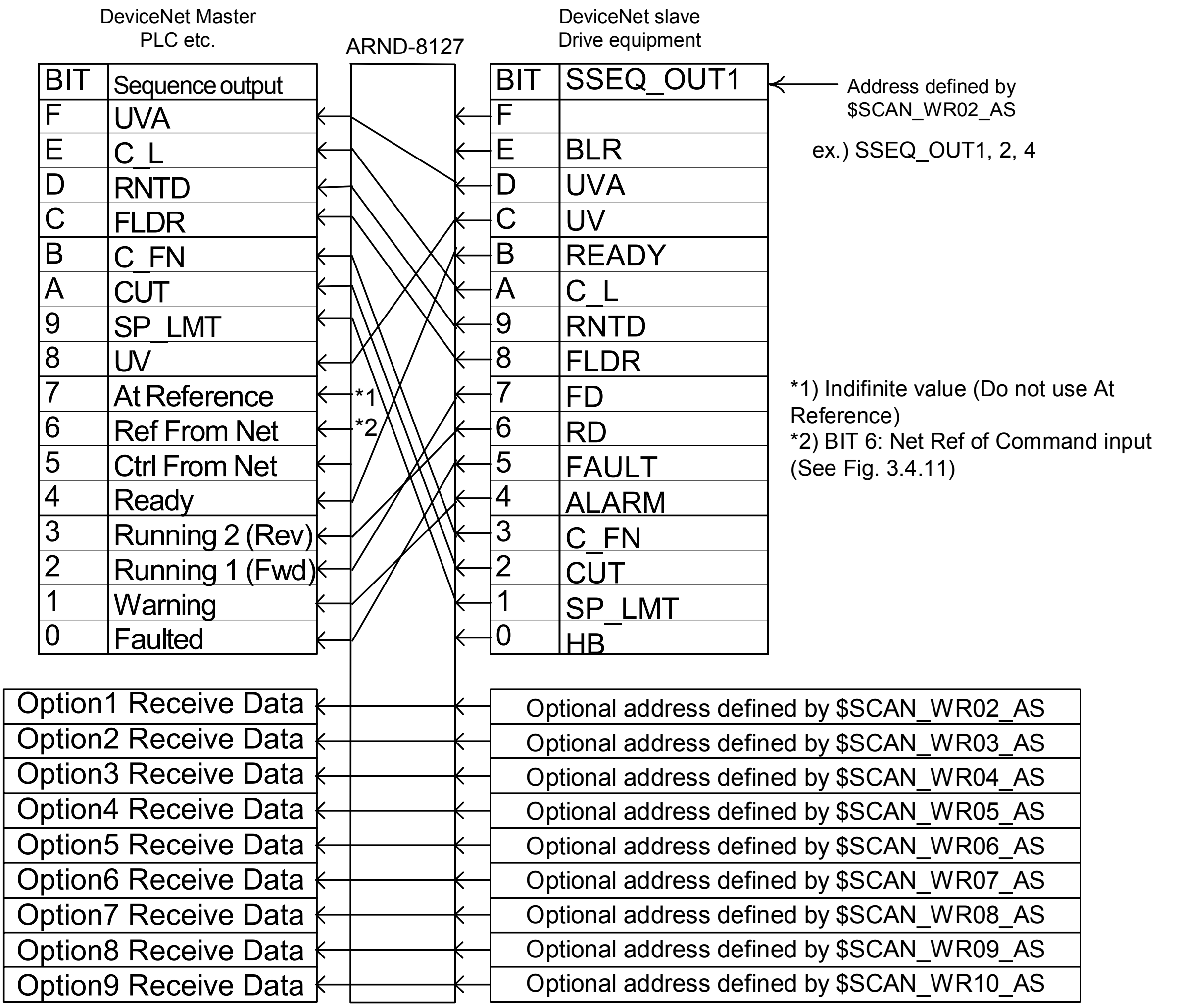


Fig. 3.4.12 DeviceNet 4W/10W Mode (Send)

Table 3.4.10 and Table 3.4.11 show the parameter settings. Since these settings may greatly affect operation of the entire system, the settings must be determined by taking the configuration of the entire PLC system into consideration. For details of settings, see the instruction manual for parameters and actually set data.

Table 3.4.10 DeviceNet Transmission Parameter Settings 4W/4W Mode

Class	Data name	Application	Setting value example	Explanation
Common	$COMM_TYPE	Transmission mode selection	2200 H	DeviceNet Transmission
	$FLG_DSCAN	Transmission between drive units	0	Do not use
	$TL_SELF_NO	Own station No.	2	Fixed
	$TL_PC_NO	PLC station No.	1	Fixed
	$TL_CYC_TIME	Cycle time	21	Fixed (Auto)
Receiving word data	$SCAN_R_SIZE	Number of receive words setting	4	Fixed
	$SCAN_R_ADRS	Start address of receive data	32	Fixed
	$SCAN_RCV01_AS	Receiving address 1	SP_REF1	Speed reference 1
	$SCAN_RCV02_AS	Receiving address 2	SERSEQDATA1	Sequence signal (input)
	$SCAN_RCV03_AS	Receiving address 3	TENS_R1	Tension (torque) reference 1
	$SCAN_RCV04_AS	Receiving address 4	Specifies data to store received data	Ex.)DROOP_GAIN_T When not used, set “DUST”.
	$SCAN_RCV05_AS ~ $SCAN_RCV10_AS	Receiving address 5 ~ 10	DUST	Do not use
Sending word data	$SCAN_W_SIZE	Number of send words setting	5	4W/4W mode select
	$SCAN_W_ADRS	Start address of send data	0	Fixed
	$SCAN_WR01_AS	Sending address 1	SP_F_OUT	Speed feedback
	$SCAN_WR02_AS	Sending address 2	SSEQ_OUT1	Sequence signal (output)
	$SCAN_WR03_AS	Sending address 3	DUST	Do not use
	$SCAN_WR04_AS	Sending address 4	Specifies data to store received data	Ex.)I1_F_DSP When not used, set “DUST”.
	$SCAN_WR05_AS	Sending address 5	T_R_OUT	Torque
	$SCAN_WR06_AS ~ $SCAN_WR10_AS	Sending address 6 ~ 10	DUST	Do not use
Drive-to-drive transmission	$TL_OP_ST1 ~ $TL_OP_ST4	Drive-to-Drive transmission opponent station number	0	Do not use
	$TL_OP_DT1 ~ $TL_OP_DT4	Drive-to-Drive transmission opponent word data address	DUST	Do not use
DeviceNet Transmission Only	$DNET_BAUD	Baud rate	0	125 [kbps]
			1	250 [kbps]
			2	500 [kbps]
	$DNET_M_MACID	Master Mac ID	0 ~ 63	Set ID of Master
	$DNET_MACID	Mac ID	0 ~ 63	Set ID of own station
	$DNET_OPTION	Option setting	1	Fixed
	$DNET_PRC_GAIN	Process input gain	-32768 ~ 32767	Process input gain
	$DNET_PRC_GAIN2	Process output gain	-32768 ~ 32767 (Do not use 0)	Process output gain
	$DNET_PRC_SCALE	Process scale	-32768 ~ 32767	Process scale
	$DNET_SP_SCALE	Speed scale	-128 ~ 127	Speed scale
	$DNET_TR_SCALE	Torque scale	-128 ~ 127	Torque scale
	$DNET_SERIAL_NO	Serial number	0 ~ 32767	Set the same number as $DNET_MACID
Conversion to physical value	CS_MOTOR_RPM	Rated motor speed	-25000.0 ~ 25000.0 min^{-1}	Set rated motor speed
	CS_SP_BASE	Base speed	8.0 ~ 125.0%	Set base speed
	MA_MOTOR_KW	Rated motor output	0.0 ~ 3276.7 kW	Set rated motor output

Table 3.4.11 DeviceNet Transmission Parameter Settings 4W/10W Mode

Class	Data name	Application	Setting value example	Explanation
Common	$COMM_TYPE	Transmission mode selection	2200 H	DeviceNet Transmission
	$FLG_DSCAN	Transmission between drive units	0	Do not use
	$TL_SELF_NO	Own station No.	2	Fixed
	$TL_PC_NO	PLC station No.	1	Fixed
	$TL_CYC_TIME	Cycle time	21	Fixed (Auto)
Receiving word data	$SCAN_R_SIZE	Number of receive words setting	4	Fixed
	$SCAN_R_ADRS	Start address of receive data	32	Fixed
	$SCAN_RCV01_AS	Receiving address 1	SERSEQDATA1	Sequence signal (input)
	$SCAN_RCV02_AS ~ $SCAN_RCV04_AS	Receiving address 2 ~ 4	Specifies data to store received data	Ex.)SP_REF1 When not used, set “DUST”.
	$SCAN_RCV05_AS ~ $SCAN_RCV10_AS	Receiving address 5 ~ 10	DUST	Do not use
Sending word data	$SCAN_W_SIZE	Number of send words setting	10	4W/10W mode select
	$SCAN_W_ADRS	Start address of send data	0	Fixed
	$SCAN_WR01_AS	Sending address 1	SSEQ_OUT1	Sequence signal (output)
	$SCAN_WR02_AS ~ $SCAN_WR10_AS	Sending address 2 ~ 10	Specifies data to store received data	Ex.)SP_F_OUT When not used, set “DUST”.
Drive-to-drive transmission	$TL_OP_ST1 ~ $TL_OP_ST4	Drive-to-Drive transmission opponent station number	0	Do not use
	$TL_OP_DT1 ~ $TL_OP_DT4	Drive-to-Drive transmission opponent word data address	DUST	Do not use
DeviceNet Transmission Only	$DNET_BAUD	Baud rate	0	125 [kbps]
			1	250 [kbps]
			2	500 [kbps]
	$DNET_M_MACID	Master Mac ID	0 ~ 63	Set ID of Master
	$DNET_MACID	Mac ID	0 ~ 63	Set ID of own station
	$DNET_OPTION	Option setting	1	Fixed
	$DNET_PRC_GAIN	Process input gain	1	Do not use
	$DNET_PRC_GAIN2	Process output gain	1	Do not use
	$DNET_PRC_SCALE	Process scale	0	Do not use
	$DNET_SP_SCALE	Speed scale	0	Do not use
	$DNET_TR_SCALE	Torque scale	0	Do not use
	$DNET_SERIAL_NO	Serial number	0 ~ 32767	Set the same number as $DNET_MACID
Conversion to physical value	CS_MOTOR_RPM	Rated motor speed	-25000.0 ~ 25000.0 min^{-1}	Not used
	CS_SP_BASE	Base speed	8.0 ~ 125.0%	Not used
	MA_MOTOR_KW	Rated motor output	0.0 ~ 3276.7 kW	Not used

3.4.5 PROFIBUS Transmission Specifications

PROFIBUS hardware specifications are shown in below.

Table 3.4.12 PROFIBUS Hardware Specifications

Item	PROFIBUS transmission board type	
	ARND-8130A	
Connector type	9 pin D-Sub connector	
Cable specification	Shielded twisted pair copper wire cable type A	
	Resistance Capacitor Loop resistance Diameter Cross-section	135 ~ 165 Ω 30 pf/m 110 Ω/km 0.64 mm > 0.34 mm²
Transmission distance	Depending on transmission speed	
	Transmission speed [kbps]	Maximum length per segment [m]
	9.6, 19.2, 45.45, 93.75	1200 m
	187.5	1000 m
	500	400 m
	1500	200 m
	3000, 6000, 12000	100 m

3.4.5.1 PROFIBUS Connection

Example of connection is shown in Fig. 3.4.13.

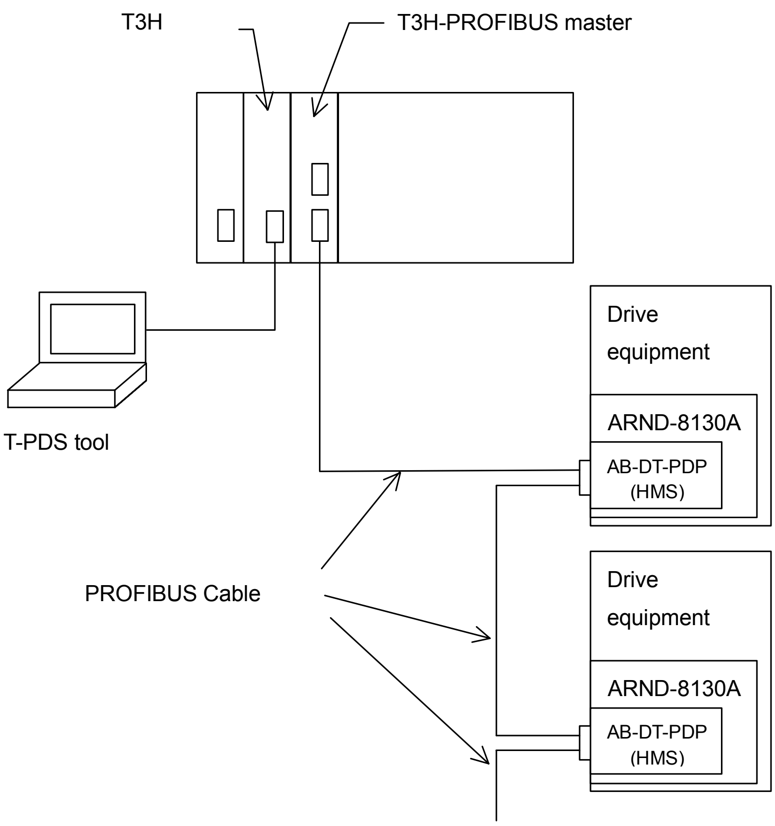


Fig. 3.4.13 Examples of PROFIBUS Connection

3.4.5.2 Scan Transmission

This transmission system transmits data at specified intervals (at regular time).
There are inputs and outputs as drive equipment. Inputs are command input of the speed reference and the sequence signal from PLC etc. Outputs are used for transmission of the actual value of speed and current, etc. from drive equipment to control / surveillance apparatus of upper side, such as PLC.

- DP Transmission Protocol (DP-V0)

This drive equipment corresponds to DP communication protocol (DP-V0) of PROFIBUS.

- Number of Transmission Words

The number of send and receive transmission words which one station (drive equipment) treats are 6 words.

- PROFIBUS Transmission Mode

The transmission mode of PROFIBUS has the mode 4 and the mode 5. The transmission mode is set up by $TL_SELF_NO. The sending and receiving contents in the case of the transmission mode 4 are shown in Fig. 3.4.14.

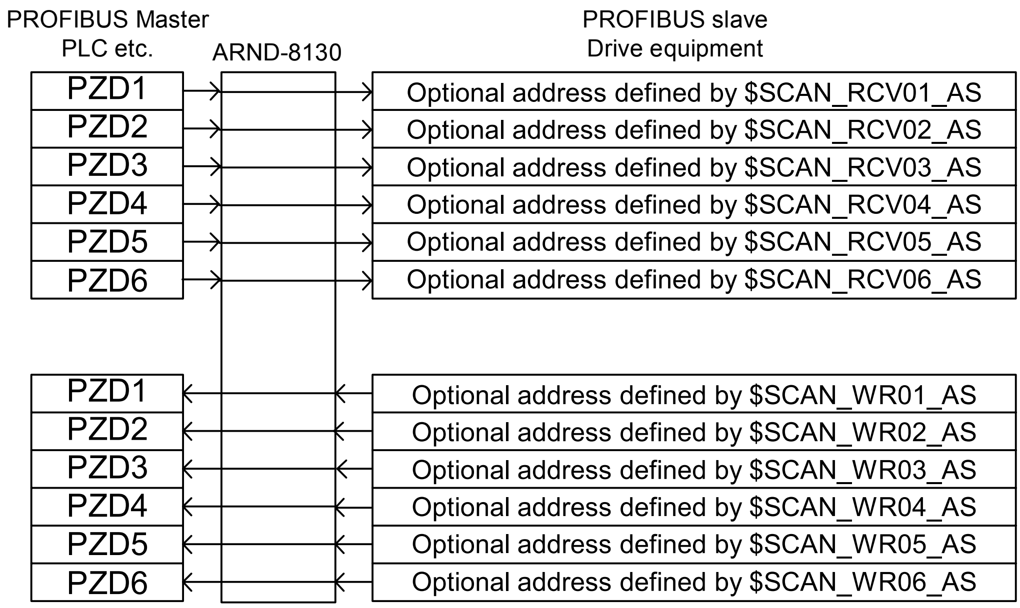


Fig. 3.4.14 PROFIBUS Transmission Mode 4

The sending and receiving contents in the case of the transmission mode 5 are shown in Fig. 3.4.15. As for the first word, sending and receiving perform bit transmission inside a transmission board. The contents of transmission of PROFIBUS master (PLC) are based on PROFIBUS Nutzerorganisation e.V. Profile for variable speed drives, PROFIDRIVE Profile number: 3 Version: 2 Edition: September 1997.

- Transmission data format

Data format of drive equipment is little endian. That is, as address in terms of bytes, upper byte of a word data is in address m+1 and lower byte of word data is address m.
This arrangement of some PLCs is reverse. In this case, it is necessary to reverse upper/lower byte in PLC application. Some master stations have this setting.

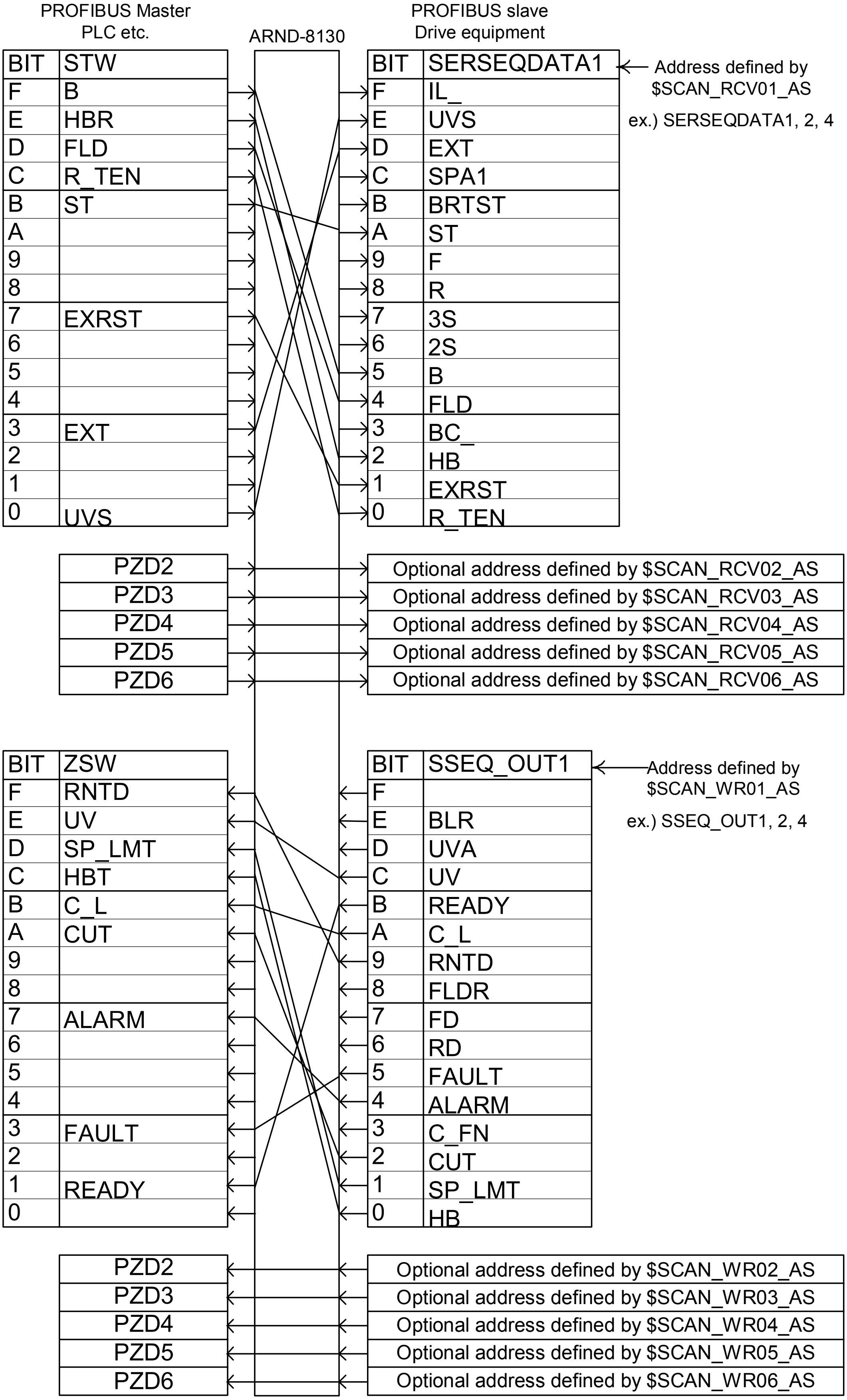


Fig. 3.4.15 PROFIBUS Transmission Mode 5

Table 3.4.13 shows the parameter settings. Since these settings may greatly affect operation of the entire system, the settings must be determined by taking the configuration of the entire PLC system into consideration. For details of settings, see the instruction manual for parameters and actually set data.

Table 3.4.13 PROFIBUS Transmission Parameter Settings

Class	Data name	Application	Setting value example	Explanation
Common	$COMM_TYPE	Transmission mode selection	0000 H	Not used
			2400 H	PROFIBUS Transmission (ARND-8130)
	$FLG_DSCAN	Transmission between drive units	0	Do not use
	$TL_SELF_NO	PROFIBUS transmission mode select	0	Not used
			1	Mode 1 (For other equipment so do not use)
			2	Mode 2 (For other equipment so do not use)
			3	Mode 3 (For other equipment so do not use)
			4	Mode 4 6W/6W through mode
			5	Mode 5 sequence bit transmission mode
	$TL_PC_NO	PLC station number	0	Not used
			1	Fixed in use
	$TL_CYC_TIME	Cycle time	21	Fixed (automatic)
Receiving word data	$SCAN_R_SIZE	Number of receive words setting	6	Scan transmission 6 words receive
	$SCAN_R_ADRS	Start address of receive data	0	Not used
			32	Fixed in use
	$SCAN_RCV01_AS	Receiving address 1	Specifies data to store received data	Free setting (Available in mode 4 ($TL_SELF_NO=4)) When not used, set “DUST”.
			SERSEQDATA1	Sequence signal (input) (Fixed in mode 5 ($TL_SELF_NO=5))
	$SCAN_RCV02_AS ~$SCAN_RCV06_AS	Receiving address 2 ~ 6	Specifies data to store received data	Set 5 data freely in case that $SCAN_R_SIZE=6. When not used, set “DUST”.
	$SCAN_RCV07_AS ~$SCAN_RCV10_AS	Receiving address 7 ~ 10	DUST	Do not use
Sending word data	$SCAN_W_SIZE	Number of send words setting	6	Scan transmission 6 words send
	$SCAN_W_ADRS	Start address of send data	0	Fixed
	$SCAN_WR01_AS	Sending address 1	Specifies data to store sent data	Free setting (Available in mode 4 ($TL_SELF_NO=4)) When not used, set “DUST”.
			SSEQ_OUT1	Sequence signal (output) (Fixed in mode 5 ($TL_SELF_NO=5))
	$SCAN_WR02_AS ~$SCAN_WR06_AS	Sending address 2 ~ 6	Specifies data to store sent data	Free setting When not used, set “DUST”.
	$SCAN_WR07_AS ~$SCAN_WR10_AS	Sending address 7 ~ 10	DUST	Do not use
Drive-to-drive transmission	$TL_OP_ST1 ~$TL_OP_ST4	Drive-to-drive transmission Other station number	0	Do not use
	$TL_OP_DT1 ~$TL_OP_DT4	Drive-to-drive transmission Other word data address	DUST	Do not use

3.4.6 Sequence Input/Output

3.4.6.1 Sequence Input

The first input data of transmission is specified to sequence data input, then set SERSEQDATA1, SERSEQDATA2 or SERSEQDATA4. Table 3.4.14 ~ Table 3.4.16 show the bit signals of each sequence input.

In general, a value of 1 indicates either the normal or the operating state, and 0 indicates either an error or stopped.

Table 3.4.14 SERSEQDATA1 Bit Signals

Bit	Signal name		Contents	
15	IL_	External interlock	1: Operation permitted Off while running causes a coast stop	
14	UVS	External safety switch	1: Operation permitted, contactor closed Off while running causes a coast stop	
13	EXT	Startup command	1: Startup command Off while running can be selected either a deceleration stop or a coast stop	
12	SPA1	Spare 1	1: Normal	
11	BRTST	Brake test	1: Brake released	
10	ST	Torque control selection	1: Tension control, 0: Speed control	When torque control is selected
		Load burden share slave selection	1: Slave (torque control)	When mechanical coupling is selected
9	F	Forward jog run command	1: Forward jog run command	
8	R	Reverse jog run command	1: Reverse jog run command	
7	3S	3-speed reference command	1: 3-speed reference command	(3S, 2S) = (0, 0): 1-speed reference command
6	2S	2-speed reference command	1: 2-speed reference command	
5	B	Brake command	1: Brake release command	
4	FLD	Field excitation command	1: Field excitation command (when EXT is off)	
3	BC_	Brake close command	0: Brake close	
2	HB	Heart beat (transmission healthy)	Periodical rectangular wave signals	
1	EXRST	External reset	1: reset request	
0	R_TEN	Reverse winding command	1: Reverse winding, 0: Forward winding (Torque direction when torque is controlled)	

Table 3.4.15 SERSEQDATA2 Bit Signals

Bit	Signal name		Contents	
15	QSTOP	Emergency Stop command	1: Emergency Stop Off while running causes a emergency deceleration stop	
14	UVS	External safety switch	1: Operation permitted, contactor closed Off while running causes a coast stop	
13	EXT	Startup command	1: Startup command Off while running can be selected either a deceleration stop or a coast stop	
12	CM_BUF1	Command Buffer bit 1		
11	CM_BUF2	Command Buffer bit 2		
10	ST	Torque control selection	1: Tension control, 0: Speed control	When torque control is selected
		Load burden share slave selection	1: Slave (torque control)	When mechanical coupling is selected
9	F	Forward jog run command	1: Forward jog run command	
8	R	Reverse jog run command	1: Reverse jog run command	
7	3S	3-speed reference command	1: 3-speed reference command	(3S, 2S) = (0, 0): 1-speed reference command
6	2S	2-speed reference command	1: 2-speed reference command	
5	N.U.	Not used		
4	FLD	Field excitation command	1: Field excitation command (when EXT is off)	
3	N.U.	Not used		
2	HB	Heart beat (transmission healthy)	Periodical rectangular wave signals	
1	EXRST	External reset	1: reset request	
0	R_TEN	Reverse winding command	1: Reverse winding, 0: Forward winding (Torque direction when torque is controlled)	

Table 3.4.16 SERSEQDATA4 Bit Signals

Bit	Signal name		Contents
15	N.U.	Not used	
14	HB	Heart beat (transmission healthy)	Periodical rectangular wave signals
13	FLD	Field excitation command	1: Field excitation command (when EXT is off)
12	B	Brake command	1: Brake release command
11	SC_PPI	Speed control P/PI change	1: P control, 0: PI control
10	2S	2-speed reference command	1: 2-speed reference command
9	3S	3-speed reference command	1: 3-speed reference command
8	R_TEN	Reverse winding command	1: Reverse winding, 0: Forward winding (Torque direction when torque is controlled)
7	ST	Torque control selection	1: Tension control, 0: Speed control
6	LB	Load barance between stands	1: Load balance control
5	N.U.	Not used	
4	N.U.	Not used	
3	N.U.	Not used	
2	UVS	External safety switch	1: Operation permitted, contactor closed Off while running causes a coast stop
1	EXT	Startup command	1: Startup command Off while running can be selected either a deceleration stop or a coast stop
0	EXRST	External reset	1: reset request

3.4.6.2 Sequence Output

The first output data of transmission is specified to sequence data output, then set SSEQ_OUT1, SSEQ_OUT2 or SSEQ_OUT4. Table 3.4.17 ~ Table 3.4.19 show the bit signals of each sequence output.

Generally, “1” indicate correct or operating state while “0” indicates error or stop state.

Table 3.4.17 SSEQ_OUT1 Bit Signals

Bit	Signal name		Contents
15	N.U.	Not used	
14	BLR	Electrical critical fault	1: Electrical critical fault
13	UVA	Electrical condition ready condition	1: Condition met
12	UV	Electrical condition	1: Condition met
11	READY	Operation ready	1: Operation ready
10	C_L	Current limit	1: Current limiting
9	RNTD	Running	1: Running
8	FLDR	Field energized	1: Field energized (current running)
7	FD	Forwarding	1: Forward detection
6	RD	Reversing	1: Reverse detection
5	FAULT	Critical fault	1: Critical fault
4	ALARM	Slight fault	1: Slight fault
3	C_FN	Cooling fan stopped	1: Cooling fan stopped
2	CUT	Discontinuation detecting	1: Discontinuation detected
1	SP_LMT	Speed limit	1: Speed limiting
0	HB	Heart beat (transmission healthy)	Periodic rectangular wave signals

Table 3.4.18 SSEQ_OUT2 Bit Signals

Bit	Signal name		Contents
15	BLR	Electrical critical fault	1: Electrical critical fault
14	UVA	Electrical condition ready condition	1: Condition met
13	SP_LMT	Speed limit	1: Speed limiting
12	SSEQ_OUT_BIT0	Optional bit 0	
11	READY	Operation ready	1: Operation ready
10	C_L	Current limit	1: Current limiting
9	RNTD	Running	1: Running
8	FLDR_TD_ON	Field energized time delay	1: Field energized (current running) after time delay
7	FD	Forwarding	1: Forward detection
6	RD	Reversing	1: Reverse detection
5	FAULT	Critical fault	1: Critical fault
4	ALARM	Slight fault	1: Slight fault
3	SSEQ_OUT_BIT3	Optional bit 3	
2	SSEQ_OUT_BIT2	Optional bit 2	
1	SSEQ_OUT_BIT1	Optional bit 1	
0	HB	Heart beat (transmission healthy)	Periodic rectangular wave signals

Table 3.4.19 SSEQ_OUT4 Bit Signals

Bit	Signal name		Contents
15	HB	Heart beat (transmission healthy)	Periodic rectangular wave signals
14	FAULT	Critical fault	1: Critical fault
13	ALARM	Slight fault	1: Slight fault
12	R_LMT	Reverse limit	1: Reverse limit
11	CUT	Discontinuation detecting	1: Discontinuation detected
10	READY	Operation ready	1: Operation ready
9	F_LMT	Forward limit	1: Forward limit
8	UV	Electrical condition	1: Condition met
7	FLDR	Field energized	1: Field energized (current running)
6	QSTOP	Emergency stop	1: Emergency stop
5	BA	Brake answer	1: Brake open
4	STALL	Low frequency overload	1: Low frequency overload
3	RNTD	Running	1: Running
2	C_L	Current limit	1: Current limiting
1	OL_A	Overload alarm	1: Overload alarm
0	SP_LMT	Speed limit	1: Speed limiting

3.4.6.3 Optional Sequence Output

Table 3.4.20 shows the optional sequence outputs

Table 3.4.20 DT_WR_SEQ Bit Signals

Bit	Signal name		Contents
15	N.U.	Not used	
14	R_LIMIT_	Reversing limit	0: Limit detection
13	F_LIMIT_	Forwarding limit	0: Limit detection
12	N.U.	Not used	
11	N.U.	Not used	
10	N.U.	Not used	
9	BA	Brake answer	1: Release detection
8	STALL	Low frequency overload	1: Low frequency overload
7	M_OH	Motor overheat	1: Motor overheat
6	N.U.	Not used	
5	N.U.	Not used	
4	STPRQ	Intermediate fault (stop request)	1: Intermediate fault
3	CSCUT_	Crop shear	0: Shear detected
2	LR	Load relay	1: Load ON
1	OL_A	Overload alarm	1: Overload alarm
0	TRQ_LMT	Torque limit	1: Limit detection

3.4.7 Serial Input/Output Signals

3.4.7.1 Serial Input Signals

Table 3.4.21 shows examples of names of data to be input through the serial communication.

Table 3.4.21 Interface Data Examples (Input)

Data name	100%-count	Functions
SP_REF1	25000	Speed reference 1
SP_REF2	25000	Speed reference 2
SP_REFA1	25000	Auxiliary speed reference 1
TENS_R1	4000	Tension (Torque) reference 1
TENS_R2	4000	Tension (Torque) reference 2 Multiplied by coefficient in EXT_TENS_GAIN.
EXT_TENS_GAIN	10000/Gain 1	Load division ratio Torque division ratio against the master is set.
IQ_LMT_EXT	4000	External current limitation value (torque limit)
SERSEQDATA1	Bit signal	Serial sequence command
SERSEQDATA2	Bit signal	Serial sequence command
DT_RD_SEQ	Bit signal	Serial sequence command
DT_DRV_SEQ	Bit signal	Drive-to-Drive transmission This is used for receiving serial sequence output (SSEQ_OUT1) of other drive.
DROOP_GAIN_T	10000	Drooping on-line gain Value in $CR_DROOP_GAIN is set as initial value.
ASPR_G_NO	0 to 3	Speed control gain selection command This is valid only when $ASPR_G_SEL = 1.
ASPR_GAIN_EXT	100/Gain 1	When the speed control gain correction setting is changed, this value is changed to newly set value with rate.

3.4.7.2 Serial Output Signals

Signals that can be output through serial transmission are shown below:

Table 3.4.22 Interface Data Examples (Output)

Data name	100%-count	Functions
SP_F_OUT	25000	Speed feedback for control use
T_R_OUT	4000	Torque reference for control use
I1_F_DSP	4000	Motor primary current feedback for monitoring
ID_F	4000	Excitation current feedback
IQ_F	4000	Torque current feedback
SSEQ_OUT1 SSEQ_OUT2 DT_WR_SEQ	Bit signal	Serial sequence output
OLCHK_REC	10000	5 minutes ΣI^2
OL20CHK_REC	10000	20 minutes ΣI^2
DT_LB_CMP_EX	25000	When 2-unit (upper/lower) load balance control master is set, the speed correction is output to the slave drive.
LD_TRQ_OUT	4000	Output is possible when the acceleration/deceleration torque calculation is executed. Load torque (including mechanical loss)
DT_ACC_TRQ	4000	Output is possible when the acceleration/deceleration torque calculation is executed. Acceleration (deceleration) torque
DT_DNDT		Output is possible when the acceleration/deceleration torque calculation is executed. Acceleration (deceleration) [0.1 min-1/s]
DT_MT_POS		Motor position (valid only when resolver 1x is used.) –32768 to 32767/revolution
DT_MT_CNT		The count value per revolution may vary depending on the value set in $DT_PG_PPR.
FI_CODE01 ~ 10	-1 ~ 399	First fault display code #1 ~ #10 When fault occurred, the fault codes are stored in order of fault occurrences from first to tenth. Below -1 are invalid data. Please refer to Table 1.5.1.
PR_CODE01 ~ 10	-1 ~ 399	Preparation display code #1 ~ #10 When ready condition isn't met, the fault codes are stored in order of code number from first to tenth. Below -1 are invalid data. Please refer to Table 1.5.1.

3.4.8 Message Transmission

This transmission system transmits data among specified stations at irregular time. This system is applicable to transmission of a lot of data, such as trace-back data if a fault occurs. This transmission system is optional system specifications.

3.4.9 Transmission Error Detection

Table 3.4.23 shows the transmission error items.

Table 3.4.23 Transmission Error Items

Item	Purpose	Content	Detection method in transmission board	Detection method by the side of CTR board
TL_F1 Own station error	CPU error etc. the failures used as the standard of transmission board replacement.	If an error occurs in drive equipment station (own station) during transmission in the online mode, own station detects TL_F1 to inform that the transmission enters the off-line mode.	• Watch dog of transmission board CPU	• CN2 signal / SIP1
TL_F2 Initialize error	Connection between transmission board and CTR board is checked.	If the mode is not changed to the on-line mode even after the power is initialized, drive equipment detects TL_F2 to inform that the transmission is in the off-line mode.		• The error in initialization processing
TL_F3 Transmission error	Transmission way connection of self-station and master-station, the error in transmission way power supply, etc. are checked. (The error of +5V power supply are detected as CTR board error)	If the transmission is in the off-line mode, drive equipment detects TL_F3 to inform that the transmission enters the off-line mode.	• Operation status of self-station • Transmission way power supply fall (PROFIBUS) • The on-line state of the station on network • The updating state of data of scan memory • The error in network power supply (DeviceNet)	• Station status / on-line mode • On-line map / master station on-line signal • Scan healthy map / healthy signal of received scan data • Received heartbeat of scan transmission (ISBus)
TL_F4 Transmission error between drives	Transmission way connection of other station in transmission between drives is checked.	If the station specified by TL_OP1_ST to TL_OP4_ST is in the off-line mode, drive equipment detects TL_F4 to inform that the transmission between drives enters the off-line mode.	• The on-line state of the station on network • The updating state of data of scan memory	• On-line map / on-line signal of other station in transmission between drives • Scan healthy map / healthy signal of received scan data

Table 3.4.24 Transmission Error Detection Function in the Combination with each Transmission Board

Item	TL-S20	ISBus	DeviceNet	PROFIBUS
TL_F1	O	O	O	O
TL_F2	O	O	O	O
TL_F3	O	O	O	O
TL_F4	O	—*1	—*1	—*1

*1) Transmission between drives is not supported

If SCAN_RCV01_AS to SCAN_RCV10_AS for designation of application are set at “Not used” ("DUST") or if TL_OP1_ST to TL_OP4_ST are set at “0”, the transmission error is not detected.

▪Support software “S20 loader (referred to as SLS)” for the TOSLINE-S20

If TOSLINE-S20 transmission is used, S20 loader (personal computer tool) is used to check the station address or scan memory allocation connected to the same system (same PC station).

Start up the “S20 loader” and select the station connection diagram menu to check the station address or scan memory allocation. Before starting up the “S20 loader”, make sure that the “LOADER” terminal on the programmable controller station and personal computer are connected with the special S20 loader cable.
For further information on operating procedures, see the separate instruction manual for S20 loader (document No. 6F3B0535).

3.4.9.1 Heartbeat

Heartbeat (signal name: HB) is assigned to the following sequence input and output. The heartbeat signal is a signal which circulates between a master station and drive equipment station while turning on and turning off. The drive equipment detects TL_F3 when this signal does not change more than a fixed period.

Receiving heartbeat (From master station to drive equipment):
Bit 2 of sequence input SERSEQDATA1, 2, 4.
Sending heartbeat (From drive equipment to master station):
Bit 0 of sequence output SSEQ_OUT1, 2, 4

The master station changes heartbeat signal and the drive equipment replays the signal as it is. Therefore, when the signal which the master station sent and the signal which the master station received from the drive equipment are different more than a fixed period, the master station can detect the error of drive equipment station.

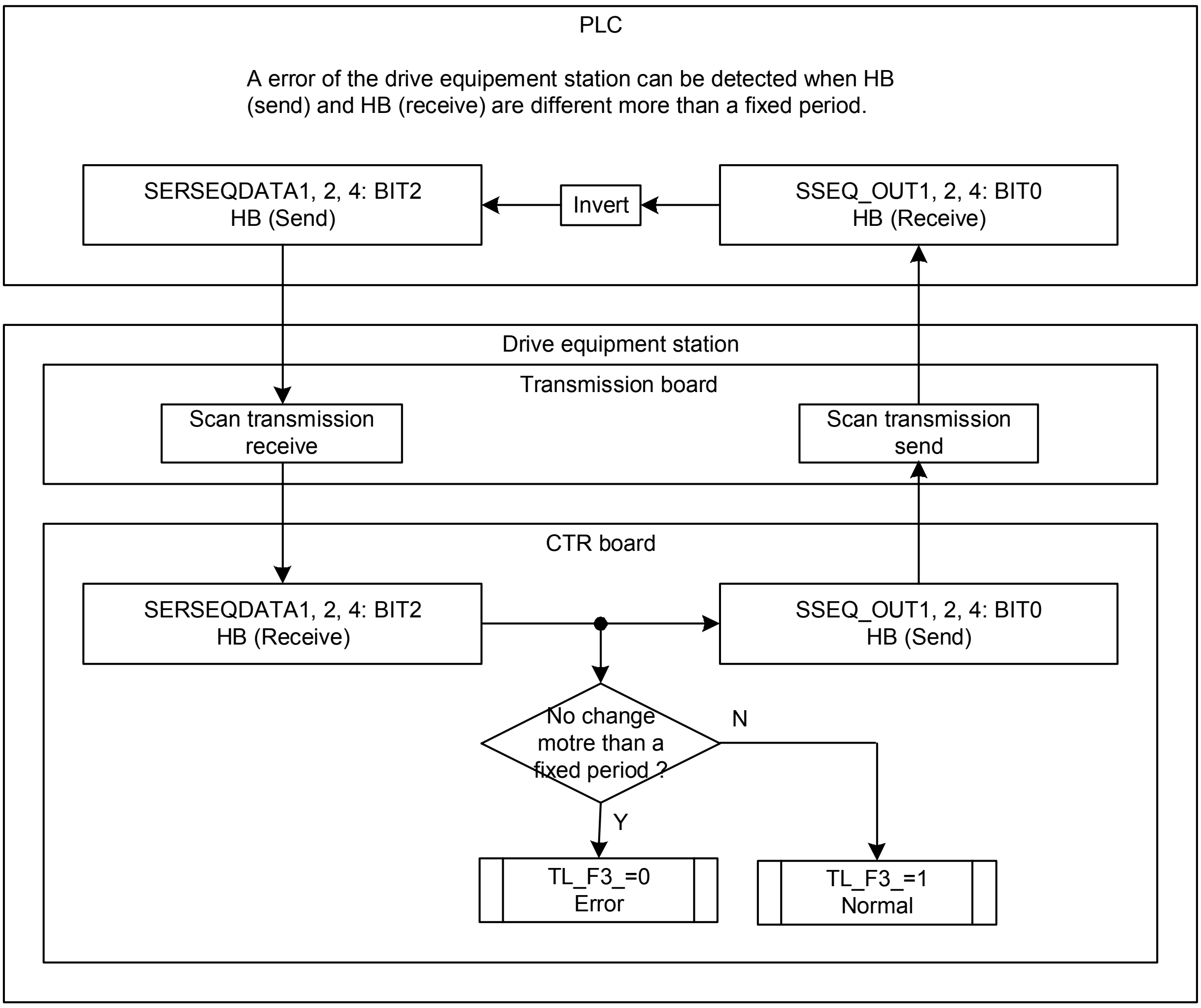


Fig. 3.4.16 The heartbeat

3.5 P I/O Input/output

3.5.1 P I/O Input

A total of 8 (DI0 to DI7) photo-coupler input buffers (PC) are provided as external hardware signal inputs. To obtain needed bit information, DI1 to DI7 are specified by 2 parameters.

Selectable DI signals are assigned to DI_EX1 to DI_EX4 bits shown on the following pages. Specify data number and bit number as a set data.

$DIn_IX (n: 1 to 7) = Data number that the required bit belongs to
$DIn_BN (n: 1 to 7) = Specifies the bit position within the data with number

Here, safety switch signal “UVS” is assigned to DIO.

An X mark in the table indicates that this equipment does not use the signal.

Table 3.5.1 DI Input Setting

Channel Number	Assigned bit selection		Supply power	Remarks
	Data selection 1 to 3 Select data number that contains needed bit signal	Bit selection 0 to 15 Select the needed bit position with number		
DI0			Power selection from INT/EXT	Usage fixed (UVS)
DI1	$DI1_IX	$DI1_BN		
DI2	$DI2_IX	$DI2_BN	Internal power	
DI3	$DI3_IX	$DI3_BN		
DI4	$DI4_IX	$DI4_BN		
DI5	$DI5_IX	$DI5_BN		
DI6	$DI6_IX	$DI6_BN		
DI7	$DI7_IX	$DI7_BN		Set to “2S” for fixed usage in the setting value change mode.

Table 3.5.2 DI_EX1 (P I/O Input Allocation)

Bit	Signal name		Contents		TMdrive-30	TMdrive-P30
15	IL_	External interlock	1: Operation permitted Off while running causes a coast stop		O	O
14	UVS	External safety switch	1: Operation permitted, contactor closed Off while running causes a coast stop		O	O
13	EXT	Startup command	1: Startup command Off while running can be selected either a coast stop or a deceleration stop		O	O
12	SPA1	Spare 1	1: Normal		O	O
11	BRTST	Brake test	1: Brake released		O	X
10	ST	Torque control selection	1: Tension control, 0: Speed control	When torque control is selected	O	X
		Load burden share slave selection	1: Slave (torque control)	When mechanical coupling is selected	O	X
9	F	Forward jog run command	1: Forward jog run command (EXT should be off.)		O	X
8	R	Reverse jog run command	1: Reverse jog run command (EXT should be off.)		O	X
7	3S	3-speed reference command	1: 3-speed reference command	(3S, 2S) = (0, 0): 1-speed reference command	O	X
6	2S	2-speed reference command	1: 2-speed reference command		O	X
5	B	Brake command	1: Brake release command		O	X
4	FLD	Field excitation command	1: Field excitation command (when EXT is off)		O	X
3	BC_	Brake close command	0: Brake close		O	X
2	SPA0	Spare 0			O	O
O	O	External reset	1: Reset request			O
0	R_TEN	Reverse winding command	1: Reverse winding, 0: Forward winding (Torque direction when torque is controlled)		O	X

Table 3.5.3 DI_EX2 (P I/O Input Allocation)

Bit	Signal name		Content	TMdrive-30	TMdrive-P3 0
15	N.U.	Not used		X	X
14	N.U.	Not used		X	X
13	N.U.	Not used		X	X
12	SPA4	Spare 4		O	O
11	SPA3	Spare 3		O	O
10	SPA2	Spare 2		O	O
9	BLA_	AC Circuit breaker		X	X
8	N.U.	Not used		X	X
7	OH_ACL_	ACL overheating		X	O
6	E_DRIVE	Emergency hard I/O operation	For external signal input	O	O
5	HOLD	Emergency speed hold		O	X
4	QSTOP	Emergency stop		O	X
3	F_LMT_	Forward limit		O	X
2	R_LMT_	Reverse limit		O	X
1	B_HLTY	Brake normal (healthy)		O	X
0	BA	Brake answer		O	X

Table 3.5.1 DI_EX3 (P I/O Input Allocation)

Bit	Signal name		Description	TMdrive -30	TMdrive -P30
15	QSTOP	Emergency stop command	Emergency stop command when 1.	O	X
14	UVS	External safety switch	Operation enabled when 1	O	O
13	EXT	Start command	Start command when 1	O	O
12	CM_BUF1	Command buffer bit 1		O	O
11	CM_BUF2	Command buffer bit 2		O	O
10	ST	Torque control selection	Tension control when 1, speed control when 0	O	X
9	F	Forward jog operation command	Forward jog operation command when 1	O	X
8	R	Reverse jog operation command	Reverse jog operation command when 1	O	X
7	3S	3-speed reference command	When 1, 3-speed reference command	O	X
6	2S	2-speed reference command	When 1, 2-speed reference command	O	X
5	N.U.	Not used		X	X
4	FLD	Exicitation command	Excitation command when 1	O	X
3	LATCH_PG_POS	PLG counter latch command	Latches at signal rising/falling	O	X
2	SPA0	Spare 0		O	X
1	EXRST	External reset	Reset request when 1	O	O
0	R_TEN	Reverse command	Reverse wind when 1, forward wind when 0	O	X

Table 3.5.2 DI_EX4 (P I/O Input Allocation)

Bit	Signal name		Description	TMdrive -30	TMdrive -P30
15	N.U.	Not used		X	X
14	SPA0	spare 0		O	X
13	FLD	Excitation command	Excitation command when 1	O	X
12	B	Brake command	Brake release command when 1	O	X
11	SC_PPI	Speed control P/PI switching	P control when 1, PI control when 0	O	X
10	2S	2-speed reference command	2-speed reference command when 1	O	X
9	3S	3-speed reference command	3-speed reference command when 1	O	X
8	R_TEN	Reverse command	Reverse wind when 1, forward wind when 0	O	X
7	ST	Torque control selection	Tension control when 1, speed control when 0	O	X
6	LB	Load balance between stands	Load balance control when 1	O	X
5	N.U.	Not used		X	X
4	N.U.	Not used		X	X
3	N.U.	Not used		X	X
2	UVS	External safety switch	Operation enabled when 1	O	O
1	EXT	Start command	Start command when 1	O	O
0	EXRST	External reset	Reset request when 1	O	O

3.5.2 P I/O Output

A desired signal of the sequence data of the results processed inside the equipment can be output from the input/output circuit board (ARND-3120). Entering data name including the sequence signal you want to output into $DOn_AS and setting the bit specification of sequence signal to $DOn_BN, you can assign the sequence signal (n = 0 to 5).

Using $SGN_DO_EX, you can inverse the bit of sequence signal output. To inverse the output polarity of “CUT” only, set $SGN_DO_EX = FF7FH.

3.6 Transmission Between Drives

Using the common memory of the TOSLINE-S20, it is possible to transmit data between drives. The following describes typical operation examples.

(1) Master/slave
If one machine is driven by two units (two motors), one is determined as master and the other as slave.
Master: Speed control
Slave: Torque control (Torque reference is input from the master.)

(2) Load balance
The operation is controlled so that two units are balanced. According to the signals from both units, the speed of a unit, to which a larger load is applied, is reduced to ensure balanced operation.

3.7 Motor Temperature Detection Circuit (TMdrive-30)

(1) Platinum temperature sensor (ST-3A type, 1 kΩ)
The figure below shows the motor temperature detection circuit. The motor temperature is detected by the platinum temperature sensor (platinum resistor) installed inside the motor. The voltage signal sent from the platinum temperature sensor, which is read through the external terminal circuit board, is converted into a digital value by the special A/D converter. This digital value is used to protect the motor from being overheated, compensate variations in secondary resistance of the motor (R2 compensation: optional) caused by temperature change, and provide the motor temperature data to external units (through the optical transmission).
When an RTD unit is not used, the resistance of the platinum temperature sensor is approximately 1 kΩ.

(2) RTD unit
If a platinum resistor sensor (100 Ω) is used as temperature sensor, it is absolutely necessary to mount a RDT unit (optional).

Since the working voltage range of the motor temperature detection circuit is 0 to 5V, the temperature detection range of the RTD unit must be set so that the assumed temperature range is included in the working voltage range.

The recommended RTD unit is listed as an optional device (Weidmüller WTS4 PT100/3V).

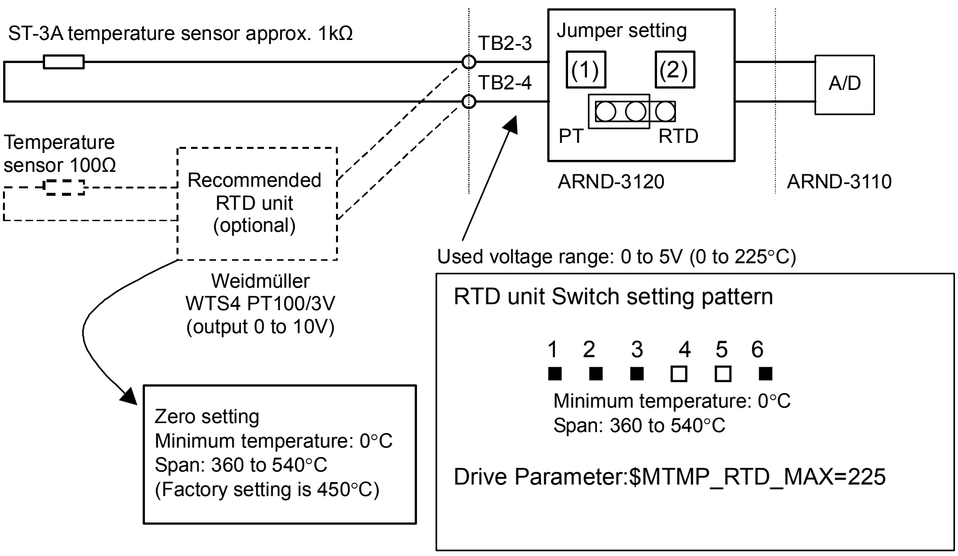


Fig. 3.7.1 Motor Temperature Detection Circuit

3.8 Analog Input/Output

3.8.1 Analog Input

The equipment is provided with 2 general-purpose analog input channels (AIN1, AIN2).

An analog signal is input from the external terminal block board (ARND-3120) and converted to a digital value through a 12-bit A/D converter. A ±10 V input is converted to count –2047 to 2047, and then data is subjected to gain ($AINn_GS) and offset ($AINn_OS) processing by software and is stored in the target data register with its storage destination signal name ($AINn_AS) specified. (n = 1, 2)

Fig. 3.8.1 shows the input circuit. These inputs are set for a voltage input and thus you have to change jumper settings to use 4-20 mA signal input.

Since this signal is directly connected to the control circuit, it is recommended to use an insulation unit for environment with much noise.

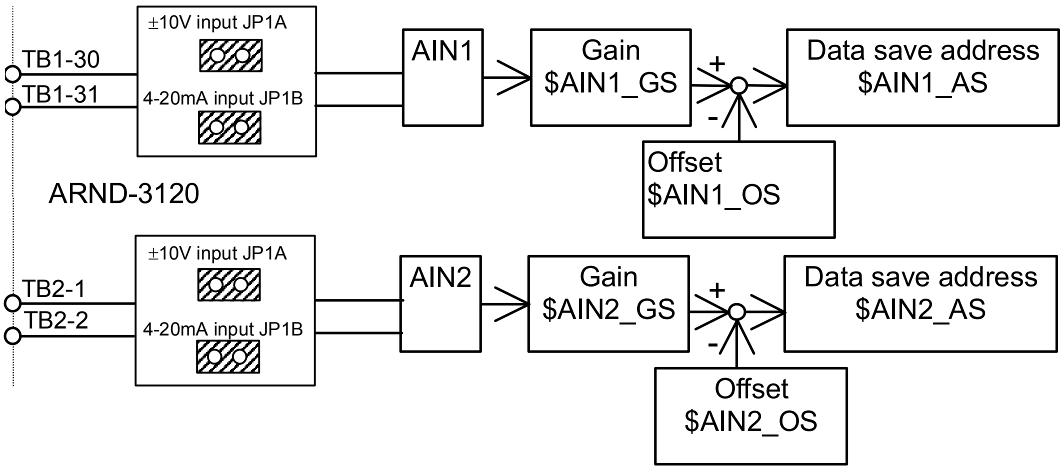


Fig. 3.8.1 Analog Input Circuit

[Setting example]
<Example 1> When speed reference is input from AIN1 in analog signal.

Set a 0 to 100% (count 0 to 25000) speed reference signal at 0 to +8 V so that it is stored in SP_REF1. Use a personal computer (maintenance tool) for the setting.
The input characteristic is shown in Fig. 3.8.2.

Set as follows:
$AIN1_OS = 0
$AIN1_AS = SP_REF1
$AIN1_GS = (25000 count/8 V) × 10 V = 31250

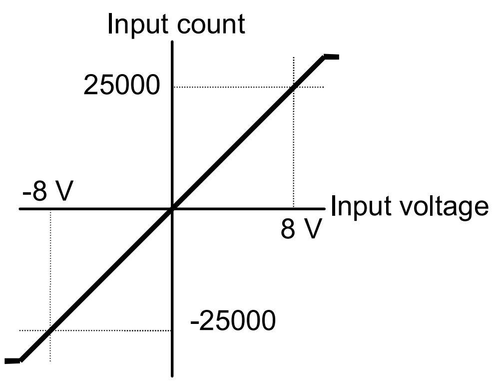


Fig. 3.8.2 Input Characteristic Example

<Example 2> When 4-20 mA is used for speed reference signal to enter from AIN1.

Setting Jumpers “JP1A to Open” and “JP1B to Close”, 20 mA when entered corresponds to about 10 V output. On the other hand, 4 mA input corresponds to 2 V output and thus set Gain and Offset so that 4 mA input corresponds to 0 reference and 20 mA to 25000 count.

Then change the software setting so that this input data is stored in the speed reference signal SP_REF1.

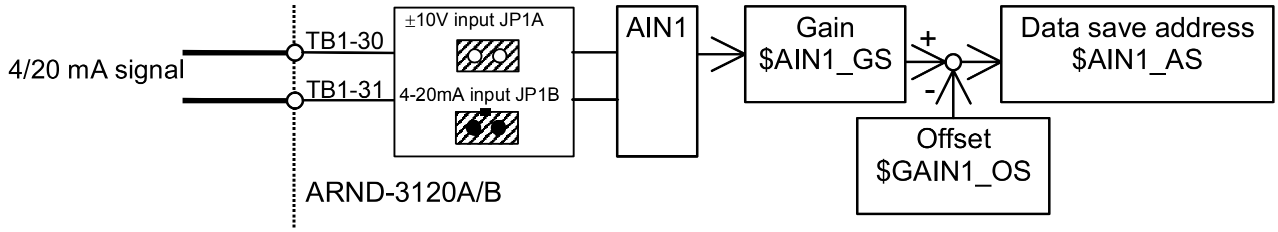


Fig. 3.8.3 Analog Input Circuit

3.8.2 Analog Output

3.8.2.1 General-purpose Analog Output

Three channels, AOUT1 to AOUT3, are provided as general-purpose analog outputs. These general-purpose analog outputs are output from the terminal circuit board (ARND-3120). You can select the output data from the menu shown in Table 3.8.1. This is done by specifying the desired data code to the setting parameters $AUTO1_CODE to $AOUT3_CODE.

<Example 1> Speed feedback is output from AOUT1 as 8 V signal at 100%-speed.
Current feedback is output from AOUT2 as 3 V signal at 100%-current.

$AOUT1_CODE: Set 2 then SP_F signal will be output with the specified gain.
$AOUT2_CODE: Set 8 then I1_F signal will be output with the specified gain.

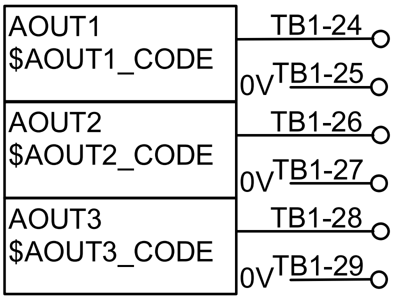


Fig. 3.8.4 General-purpose Analog Output Configuration

Table 3.8.1 Analog Output Code

Code	Data name	100%-count	D/A output	Description
0	Option		Separate setting	Set output data name, gain and offset separately for AOUT1, 2.
1	SP_R	25000/100%	8 V/100%	Speed reference (after rate)
2	SP_F	25000/100%	8 V/100%	Speed feedback
3	T_R	4000/100%	3 V/100%	Torque reference
4	IQ_R	4000/100%	3 V/100%	Torque current reference
5	IQ_F	4000/100%	3 V/100%	Torque current feedback
6	FL_R	10000/100%	8 V/100%	Magnetic flux reference
7	I1_R	4000/100%	3 V/100%	Primary current reference
8	I1_F	4000/100%	3 V/100%	Primary current feedback
9	FREQ	10000/100%	8 V/100%	Frequency

To output signals not listed in the table above, select 0 as code number and set data name, D/A gain and offset in accordance with the channel.

$AOUTn_CODE:	Set 0	
$AOUTn_OP_AS:	AOUTn	Data name
$AOUTn_OP_GS:	AOUTn	D/A conversion gain
$AOUTn_OP_OS:	AOUTn	Offset n: 1 to 3

Gain setting is the count for 10 V output.

<Example 2> SP_F (speed feedback) is output as 10 V signal at 100%-speed.
SP_F (speed feedback) is internally weighted 100% with 25000 count. To output 25000 count as 10V, set the gain to 25000.
Analog output data names are normally protected. When they are protected, data names cannot be changed. To release the protection, set bits 5 to 7 (corresponds to AOUT1 to 3) of $DA_AS_PRTOFF to 1. Analog output settings can be changed anytime but be careful when you change the setting because if the output is used outside when it is changed, it may cause disturbances.

3.8.2.2 Measurement Analog Output

Five channels, D/A1 to D/A5, are provided as measurement analog outputs, and these are outputs from the CTR board (ARND-3110). The configuration is shown below. Output data, gain and offset can be set on the PC screen.

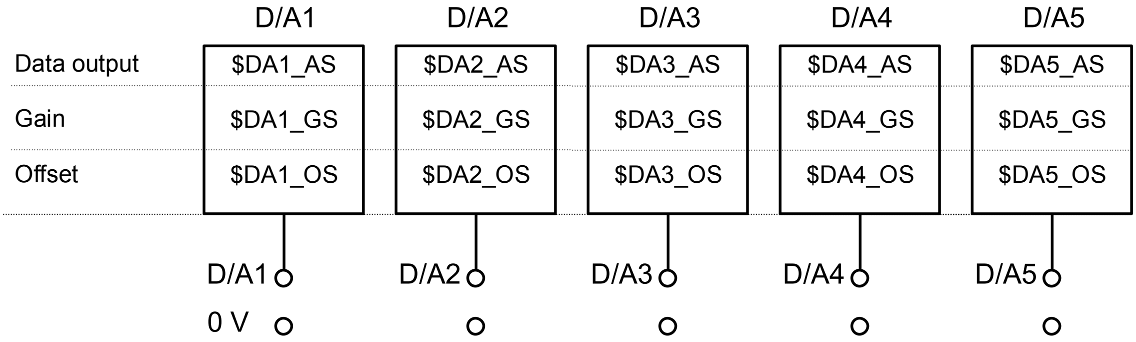


Fig. 3.8.5 Measurement Analog Output Configuration

[Setting examples]
<Example 1> Speed feedback (SP_F) is output from D/A1.
The settings are made so that SP_F in a range of 0 to 125% (0 to 31250 counts) is output at 0 to +10 V. These settings are made using the personal computer (maintenance tool).
$DA1_AS = SP_F
$DA1_GS = 31250 (125%)
$DA1_OS = 0 (0%)

<Example 2> Torque reference (T_R) is output from D/A2.
The settings are made so that T_R in a range of 50 to 125% (2000 to 5000 counts) is output at 0 to +10 V.
$OA2_AS = T_R
$OA2_GS = (5000 – 2000) = 3000 (75%)
$DA2_OS = 2000 (50%)

Analog output data names are normally protected. When they are protected, data names cannot be changed. To release the protection, set bits 0 to 4 (corresponds to DA1 to 5) of $DA_AS_PRTOFF to 1. Analog output settings can be changed anytime but be careful when you change the setting because if the output is used outside when it is changed, it may cause disturbances.

3.9 Options (TMdrive-30)

3.9.1 Motor Mounted Fan Circuit

It is also possible to manufacture a motor mounted fan circuit as an option or house it in the equipment.

When using it, be sure to check the rotation direction of the fan and change its phase rotation if necessary. Reverse rotation of the fan cannot yield desired cooling effect.

When the auxiliary contacts of the mounted fan ON/OFF MCCB (contact is closed when turned on) are connected to the P I/O input terminal on the input/output circuit board (XIO: ARND-3120) and the settings are made according to "3.5.1 P I/O Input", to interlock the fan rotation with equipment operation.

For detailed interface, see the wiring of the schematic connection diagram.

4 Structure

The dimensions of TMdrive-30 are shown in Section 4.1. The dimensions of TMdrive-P30 are shown in Section 4.2.

4.1 Dimensions of TMdrive-30

1500, 2000 frames

Approximate mass: 1300kg

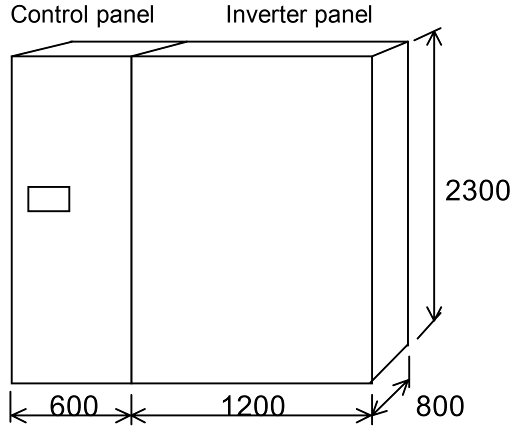


Fig. 4.1.1 1500, 2000 frames

3000, 4000 frames

Approximate mass: 2300kg

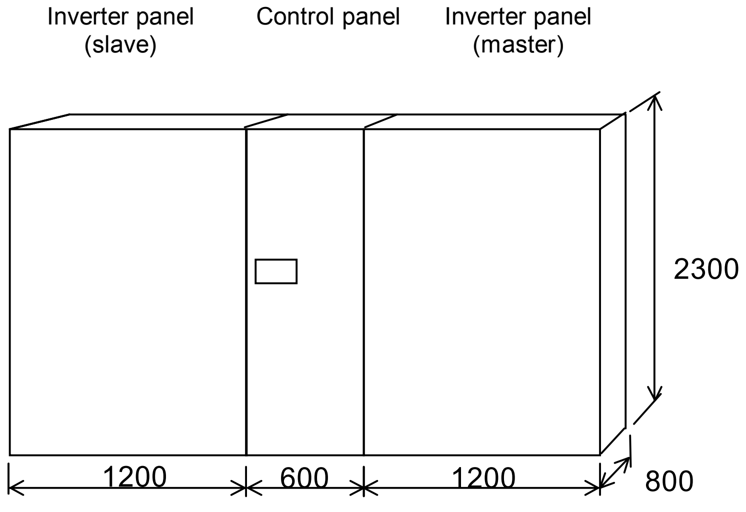


Fig. 4.1.2 3000, 4000 frames

4.2 Dimension of TMdrive-P30

2000 frames

Approximate mass: 1600kg

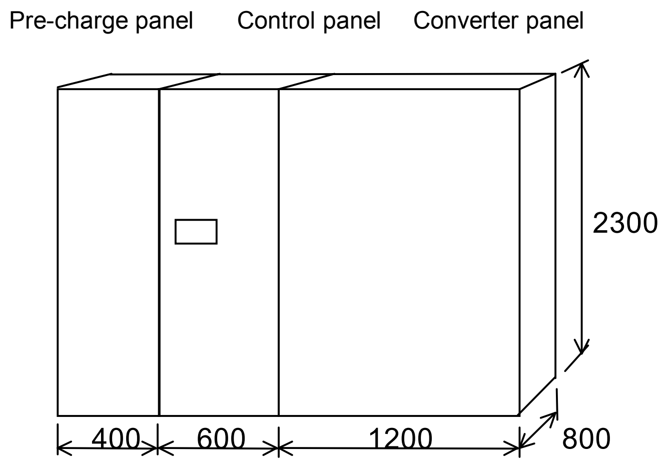


Fig. 4.2.1 2000 frames

4000 frames

Approximate mass: 2600kg

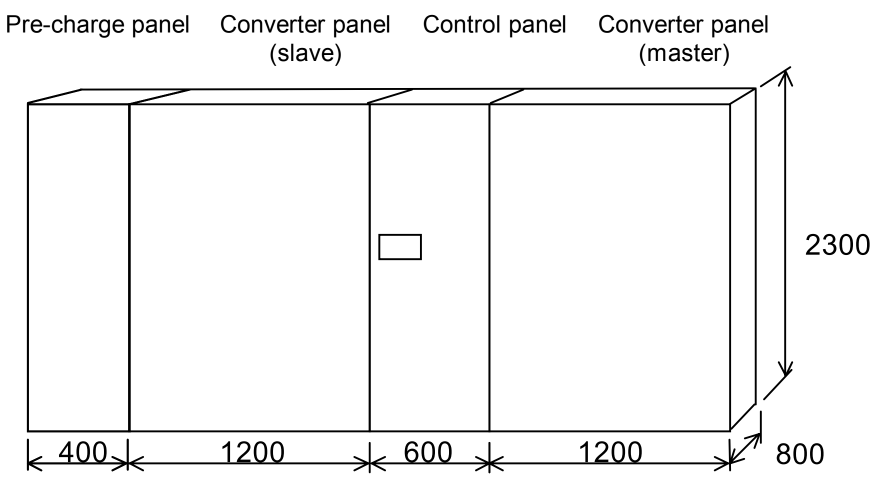


Fig. 4.2.2 4000 frames

<Notes>

(1) Front panel maintenance is adopted for all units.

(2) The dimensions indicated in the figures do not include the following.
- Channel base, lifting angle, side cover.
- Fans, handles and other protruded sections.

(3) To install in an electric room, it is necessary to reserve space for maintenance (For details, see the dimensions drawing).

4.3 Operation Panel

The standard type operation panel is shown in Fig. 4.3.1.

The LED display consists of 7 segments x 3 characters. The model name, software number, operation data, operation preparation indication and FI (First Fault) are displayed with their abbreviations and numeric values. Fig. 4.3.2 shows the display characters.

Three operational status display LEDs are provided: READY (green), RUN (green), and a LED used both as ALARM and FAULT (red).

The FAULT REST switch is used for display and operation. This switch functions differently depending on how you press. This is used not only for reset operation (FAULT REST operation) but also for switching between display and operation.

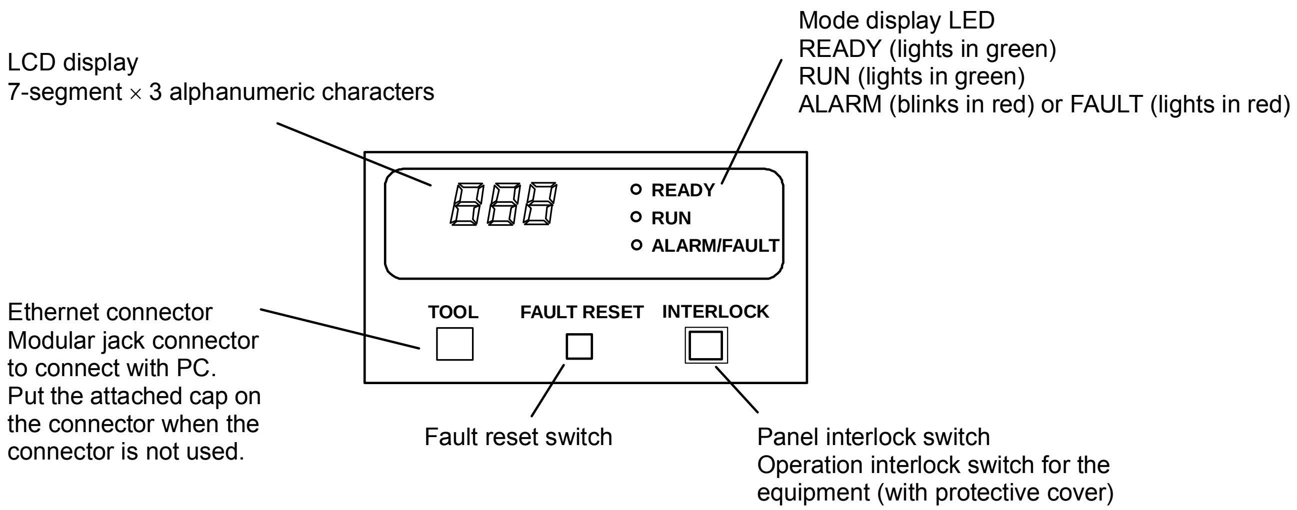


Fig. 4.3.1 Operation Panel

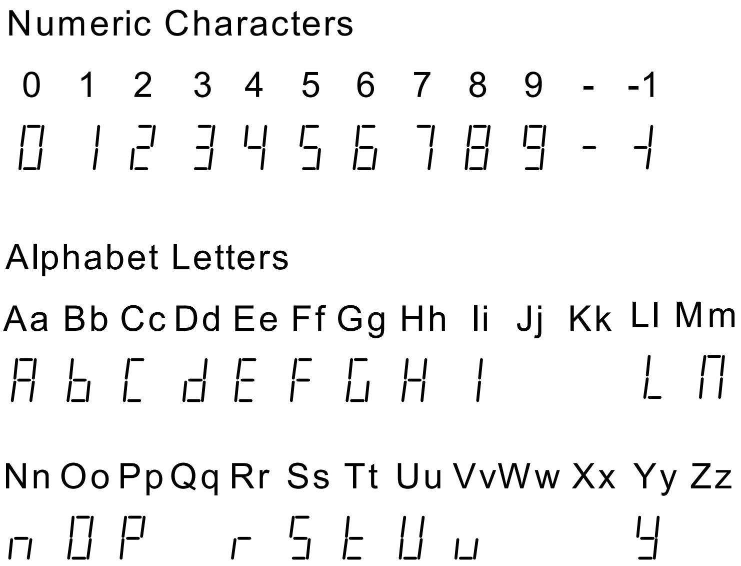


Fig. 4.3.2 LED Display (7-Segment Characters)

Fig. 4.3.3 shows the overall screen transitions. Screen switching basically takes place at three-minute intervals. Pressing FAULT REST for five seconds triggers one operation.

When the power supply is turned on, the model name and software version are displayed for three seconds, respectively. Then the display mode is entered and the display is automatically switched between operation data display, operation preparation display, and FI (FIrst Fault) display, in accordance with the READY, ALARM and FAULT occurrence status.

If the READY condition is satisfied and ALARM is detected, the operation data display continues and the operation preparation indication is shown cyclically. When a FAULT occurs, FI display appears.

Operation data display: Operation data is shown in units of %.
Operation preparation display: The sequence signals that are not satisfied are indicated with a code number.
FI display: The fault sequence signals are indicated with code numbers in order of occurrence.

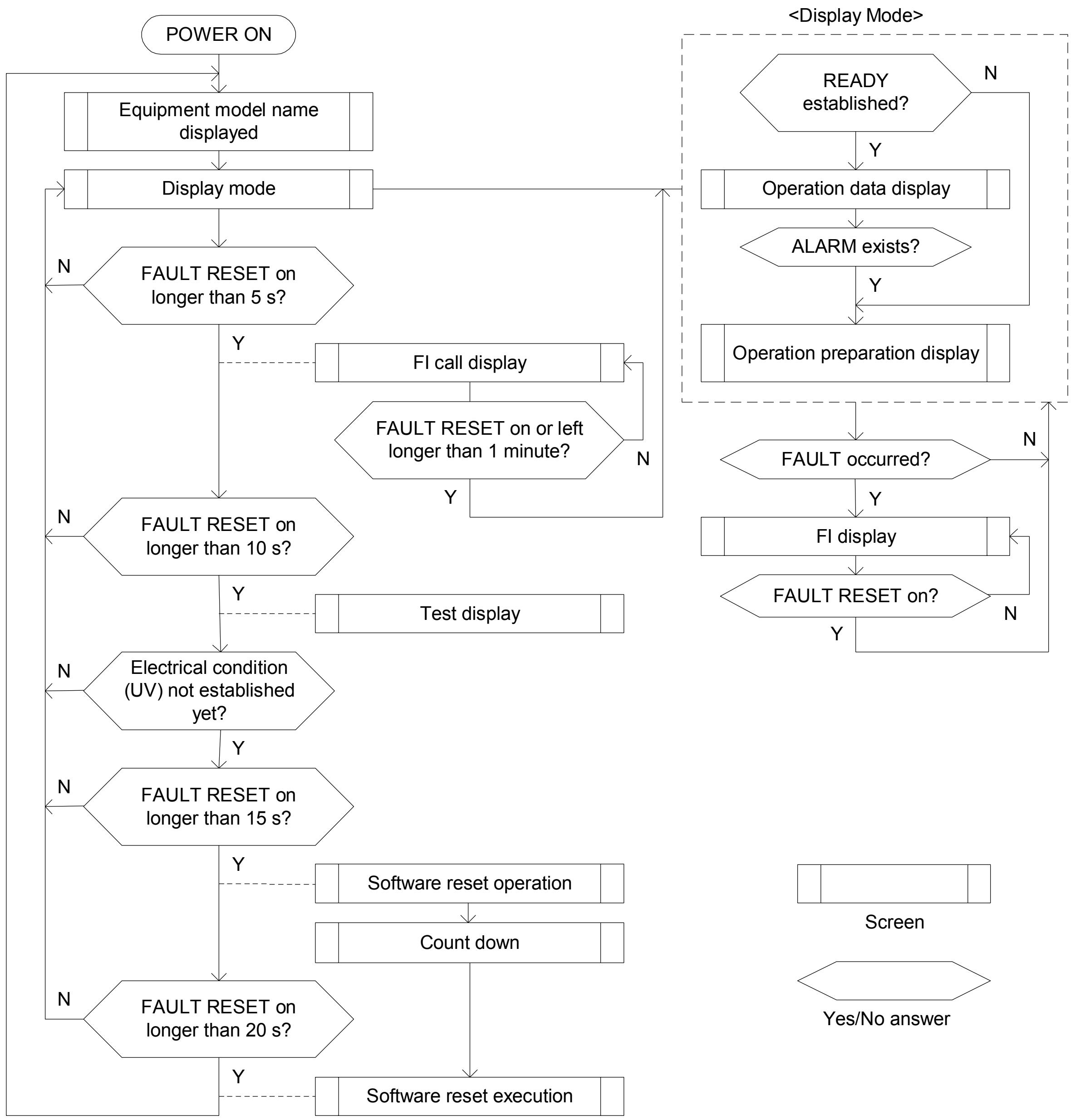


Fig. 4.3.3 Entire Configuration of Display Screens

The display items are described below.

4.3.1 Equipment Model Name/Software Version Display

When power is turned on, the model name and the lower three digits of the software version are displayed.

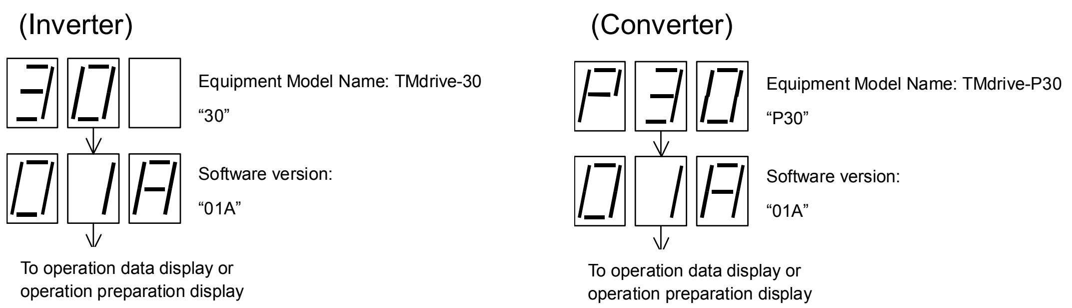


Fig. 4.3.4 Equipment Model Name/Software Version Display

4.3.2 Operation Data Display

When "READY" is established, operation data will be displayed. Each screen will be displayed cyclically at 3-second intervals.

Numerical display range: -999 to 999%

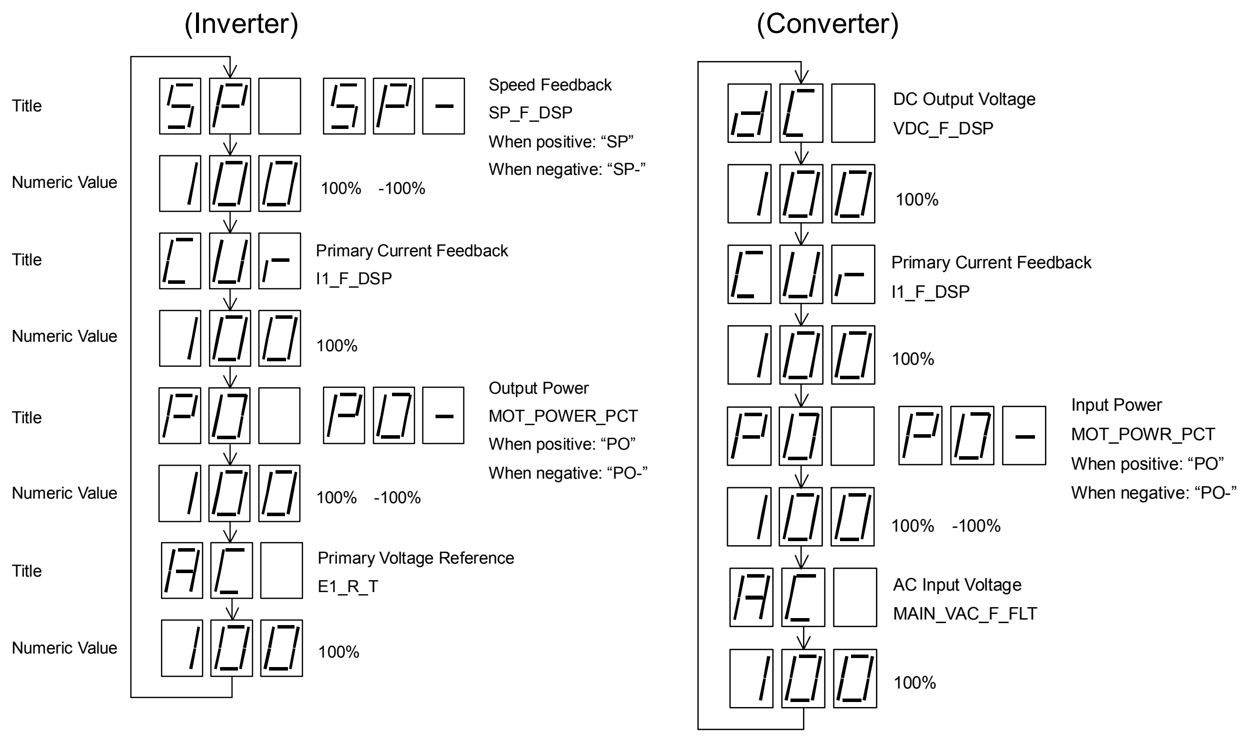


Fig. 4.3.5 Operation Data Display

4.3.3 Operation Preparation Display

When the “READY” condition is unsatisfied, an unsatisfied sequence signal code number (three digits) is displayed. The title “PI-“ and up to four code numbers are displayed cyclically. For example, if there are two unsatisfied signals, three screens are displayed cyclically.

See Table 1.5.1 for code Nos. of sequence signals.

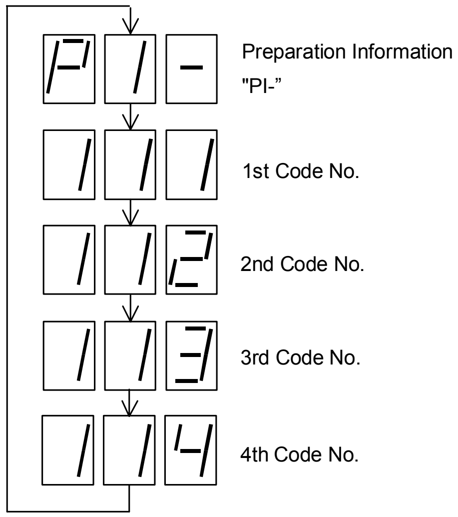


Fig. 4.3.6 Operation Preparation Display

4.3.4 FI (FIrst fault) Display

When a FAULT occurs, the fault sequence signal numbers (3 digits) for the faults that occurred within 10ms after the first fault occurrence are displayed in order of occurrence (faults that occurred after 10ms are not displayed). Title “FI-“ and up to four code numbers are cyclically displayed at three-second intervals. As in the operation preparation display, if two fault signals are detected, three screens are displayed cyclically.

See Table 1.5.1 for code Nos. of sequence signals.

Pressing the “FAULT RESET” button switches the screen to the operation preparation screen where the currently occurred faults are displayed in order of code numbers. Whether it is operation preparation display or FI display can be distinguished with the title (“PI-“ or “FI-”).

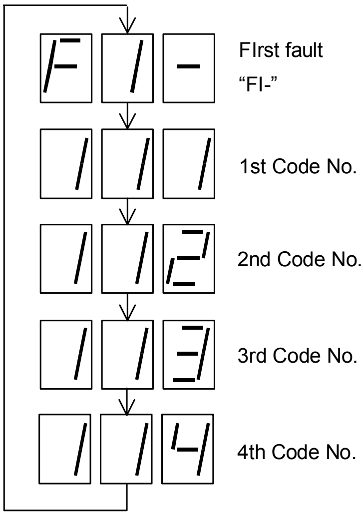


Fig. 4.3.7 FI (FIrst fault) Display

4.3.5 FI Call

Pressing “FAULT RESET” longer than 5 seconds in the Display mode will change the screen to the previous FI display. (The screen will be the same as that in 4.3.4.)

The FI display can be redisplayed by this method even if FI display is overlooked when a fault has occurred.

4.3.6 Test Display

Pressing “FAULT RESET” longer than 10 seconds in the Display mode will appear Test display following 4.3.5. In Test display, all segments will be lit following display of software versions. This display is used in checking software versions of the main control board and LED faults.

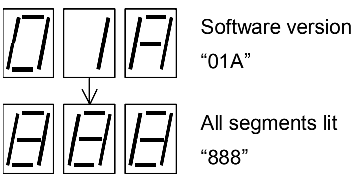


Fig. 4.3.8 Test Display

4.3.7 Software Resetting Operation

Pressing "FAULT RESET" longer than 15 seconds in the Display mode when the electric condition (UV) is off will set the Software Reset Operation screen following on the operations in 4.3.5 and 4.3.6.

In software resetting, initialize the system as in POWER-ON resetting while the power is turned on. By this, setting changes that need initialization and initialization of the TOSLINE-S20 Transmission Option Boards (ARND-8217) can be executed by panel operation without shutting down the power.

When stopping operation, release the button before counting down finishes.

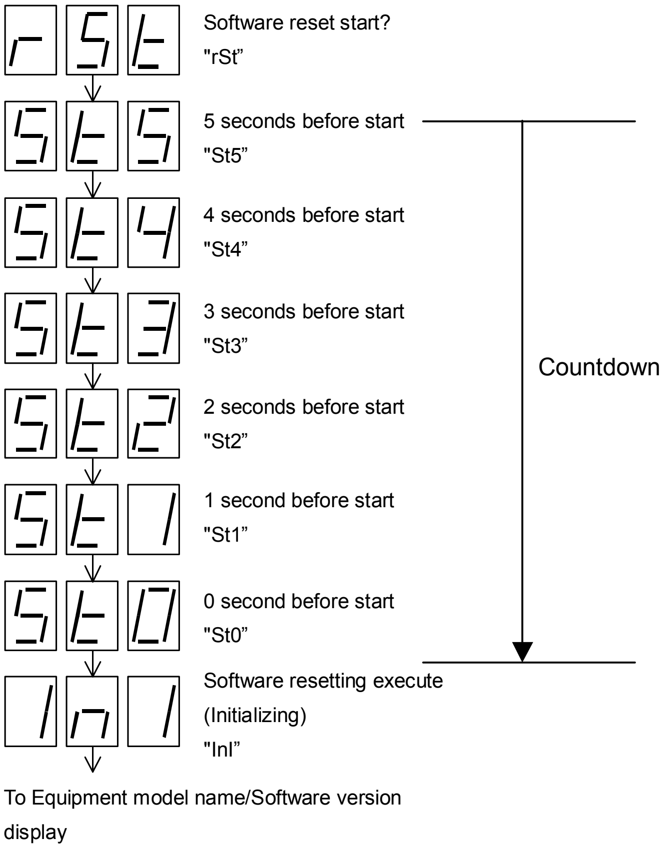


Fig. 4.3.9 Software Resetting

4.3.8 Software Error Display

When power is turned on, the software in the FLASH memory is checked. If an error is detected, software error display appears.

When “Software Error” is displayed, the main control functions will not operate, disabling transmission and connection of adjustment tools. Replace the main control board.

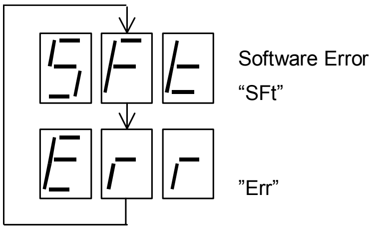


Fig. 4.3.10 Software Error Display

4.3.9 Relief Mode Display

If the main control CPU (PP7) malfunctions due to a drive unit setting error or hardware fault, the adjustment tool may not be able to connect in the normal way. Especially, if data for tool connection (MAC address, IP address, subnet mask, gateway address, panel name) is incorrect, the adjustment tool cannot be connected.

In this case, using the rescue mode enables you to connect the adjustment tool to the drive unit and correct and save the setting values in the relevant file.

The Relief mode can be set by manual selection and automatic selection as follows:

a. Turn the power on while pressing FAULT RESET. (Manual selection: “999”)
b. The MAC address of the main control board is an error. (Auto selection: “999”)
c. Interrupt signal of the main control CPU (PP7) has become an error during normal operation (Auto selection: “998”)

Three-digit code number display is used. In the cases of “a” and “b” that are switching at startup time, “999” is displayed. In the case of “c” that is switching during normal operation, “998” is displayed. All of the operation status LEDs (READY, RUN, and FAULT) blink.

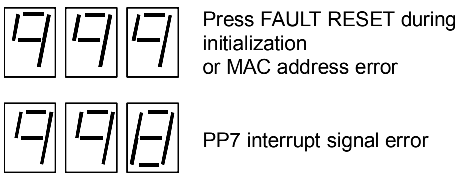


Fig. 4.3.11 Relief Mode Display

In the rescue mode, the adjustment tool is connected, ignoring the MAC address, IP address, subnet mask, and gateway address. The panel name is “TM drive.” When you use the rescue mode, be sure to check and correct these settings.

If the system does not recover even if setting values are corrected, hardware error has probably occurred. Save the setting values to a file in the rescue mode and replace the main control board.

5 Operation

5.1 Main Circuit Operation

5.1.1 Main circuit Operation of Two-level Inverter

Fig.5.1.1 shows the main circuit operation for one-phase (U-phase) of the two-level inverter.

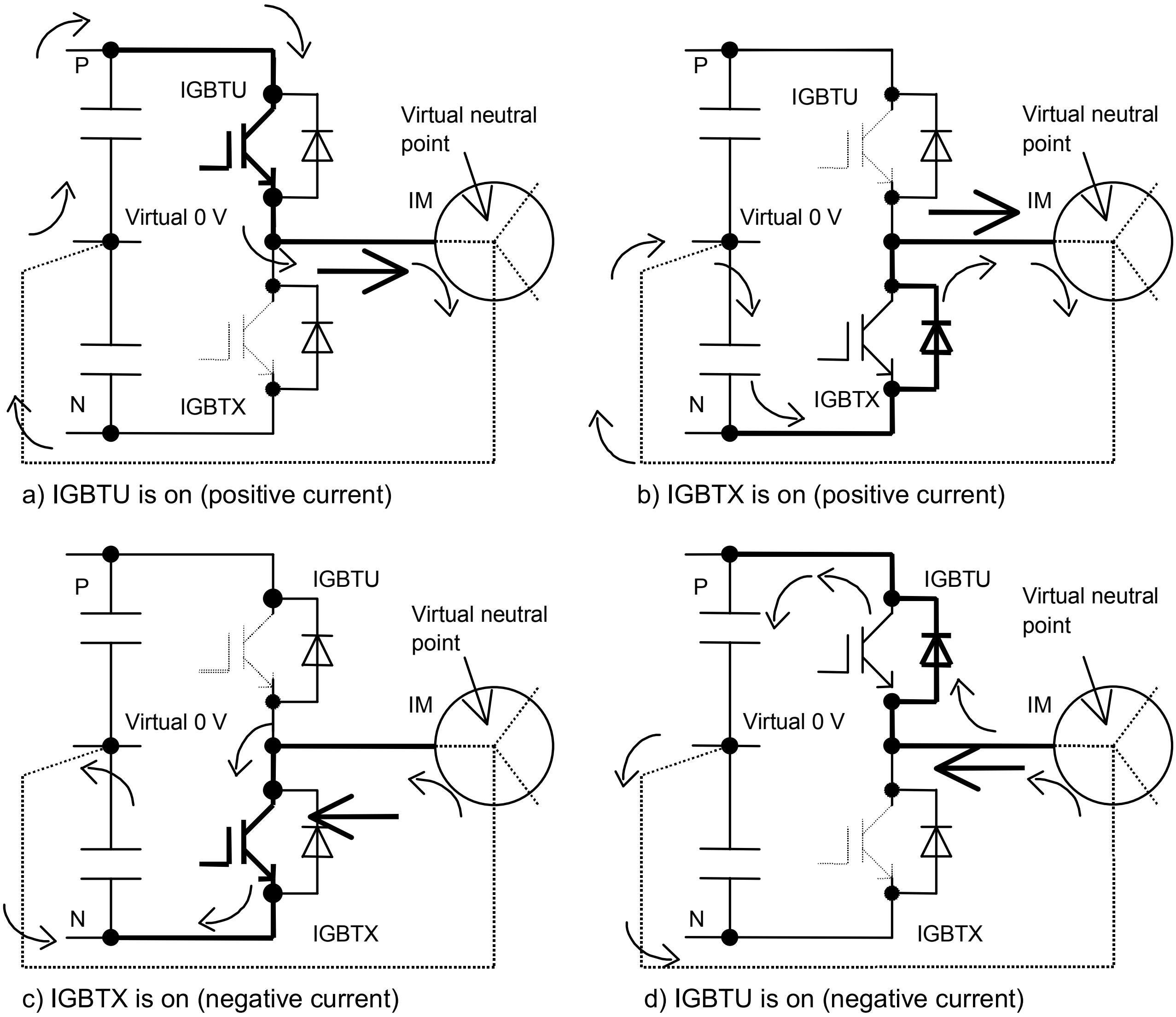


Fig. 5.1.1 U-phase Main Circuit Operation

The following describes the IGBT control of the U-phase.

The main circuit for the U-phase is composed of IGBTU and IGBTX. As shown in Fig.5.1.1 a) to d), several operation modes are provided according to the load current direction and gate signal. These operation modes are controlled to output the sine wave voltage. As a matter of convenience, it is presumed that 600 V dc is input and continues as follows.

(1) When positive current is flowing into the motor:
When flowing the positive current, two states a) and b) are controlled by the on/off control of the IGBTU and IGBTX to control the voltage output from the U-phase.

a) IGBTU is on. (IGBTX is off.)
IGBTU is on and IGBTX is off.
At this time, the IGBT1 outputs the positive potential (P) of the DC power supply. After that, the current flows through a loop so that it flows into the motor and returns to virtual 0 V of the converter through the virtual neutral point. (Actually, even though the neutral point is not connected, it seems that the current flows through equivalent neutral point since the V and W phases are provided.)

b) IGBTX is on. (IGBTU is off.)
IGBTX is on and IGBTU is off.
When positive current is applied, the current does not flow into the IGBTX even though the IGBTX is on (gate signal on) and the current flows through a diode built in the IGBTX package. At this time, the negative potential (N) of DC power supply will be output. After that, the current flows through a loop so that it flows into the motor and returns to virtual 0 V of the converter through the virtual neutral point.

(2) When negative current is flowing into the motor:
When flowing the negative current, two states c) and d) are controlled by the on/off control of the IGBTU and IGBTX to control the voltage output from the U-phase.

c) IGBTX is on. (IGBTU is off.)
IGBTX is on and IGBTU is off.
At this time, since the IGBTX is on, the output of the U-phase becomes the negative potential (N) of DC power supply. After that, the current flows through a loop so that it flows into the motor and returns to virtual 0 V of the converter through the virtual neutral point.

d) IGBTU is on. (IGBTX is off.)
IGBTU is on and IGBTX is off.
When positive current is applied, the current does not flow into the IGBTU even though the IGBTU is on (gate signal on) and the current flows through a diode built in the IGBTU package. At this time, the positive potential (P) of DC power supply will be output. After that, the current flows through a loop so that it flows into the motor and returns to virtual 0 V of the converter through the virtual neutral point.
When flowing the positive or negative current, the current may flow into the IGBT or diode. In both cases, however, the voltage is the same. That is, when the gate signal to the IGBTU is on, the voltage becomes the positive potential (P). On the contrary, when the gate signal to the IGBTX is on, the voltage becomes the negative potential (N).

(3) Output voltage
In a two-level inverter (such as TMdrive-10), performs the on/off control of each IGBT at periodic intervals.

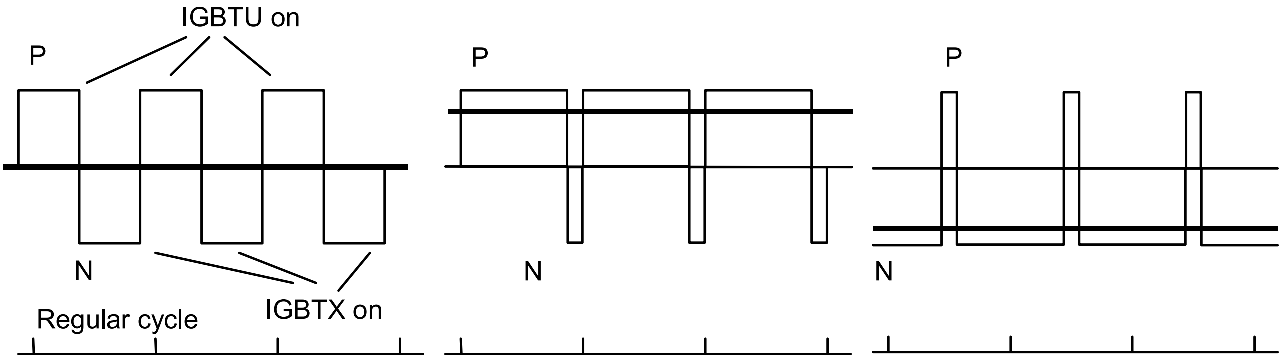
- When the power supply to IGBTU is made the same as that to IGBTX during a specified period, the average output voltage becomes zero.
- When the IGBTU turn on period is made longer and the IGBTX turn on period shorter, the average voltage becomes positive.
- When the IGBTX turn on period is made longer and the IGBTU turn on period shorter, the average voltage becomes negative.

That is, by changing the turn on period of each IGBT, it is possible to control the output voltage to a desired level ranging from positive voltage to negative voltage.

As described previously, it is possible to output the sine wave AC voltage with a desired frequency and voltage level by the on/off control of the IGBTU and IGBTX.

Fig. 5.1.2 shows the waveform of the inverter output voltage (VM), and the IGBTU and IGBTX states.

Fig. 5.1.3 shows the waveform of the inverter output voltage (rectangular wave) and the average voltage (sinusoidal wave).



a) 0 V output b) + (positive) output c) - (negative) output

Fig. 5.1.2 Average Output Voltage

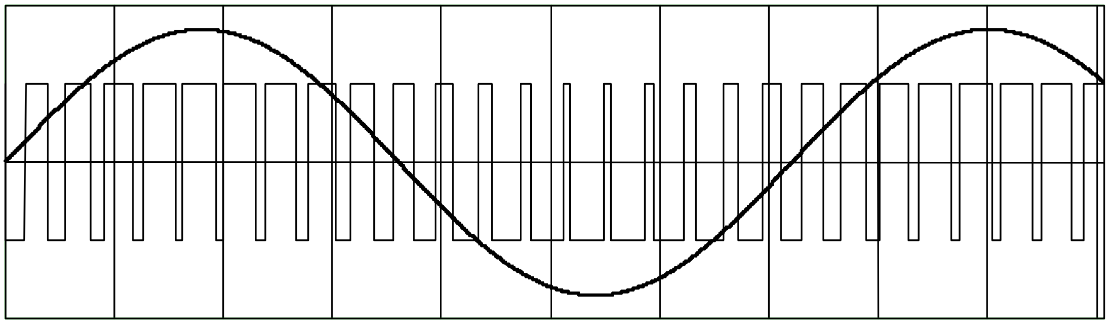
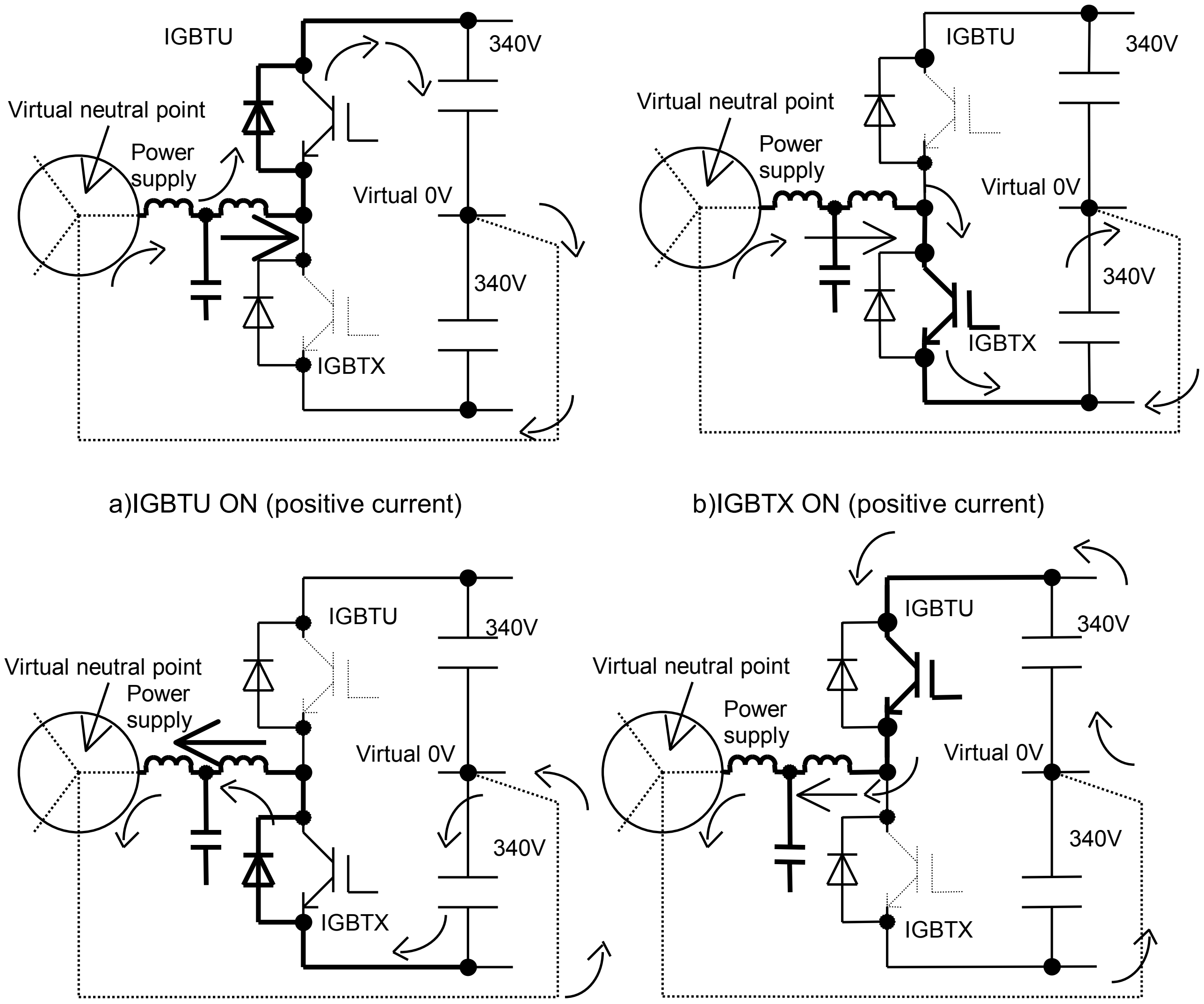


Fig. 5.1.3 PWM Waveform

5.1.2 Two-level Converter Operation

Fig. 5.1.4 shows the main circuit operation for one-phase (U-phase) of the two-level converter (TMdrive-P10). This figure shows the main circuit operation for one-phase (U-phase) of the converter when DC voltage is 680V.



a)IGBTU ON (positive current)

b)IGBTX ON (positive current)

c)IGBTX ON (negative current)

d)IGBTU ON (negative current)

Fig. 5.1.4 U-phase Main Circuit

The following describes the IGBT control of U-phase.

The main circuit for U-phase is composed of IGBTU and IGBTX. As shown in Fig. 5.1.4 a) to d), operation mode varies depending on the load current direction. These operation modes are controlled so that DC voltage will be identical to the voltage reference and the power supply current becomes a sine wave. In the description below, for convenience, it is assumed that 460Vac is input.

(1) When positive current flows in the power supply (motor running)
By controlling two states a) and b) by turning on/off IGBT and IGTX, output voltage from U-phase is controlled.

a) IGBTU is turned on (IGBTX off)
IGBTU turns on and IGBX turns off.
If the DC voltage is lower than the power supply voltage, the current flows into the DC capacitor through the diode. On the other hand, even if the DC voltage is higher than the power supply voltage, when IGBTX is turned off, IGBTU causes the current (that was flowing in the direction pointed by the arrow into the power supply so far) to flow into the DC capacitor through FWD current of IGBTU.
Then the current flows through the loop that starts from virtual 0V of the converter and returns to the neutral point of the power supply. (The neutral point is not connected actually but it can be assumed that the current flows through the equivalent neutral point since V and W phases are provided).

b) IGBTX is turned on (IGBTU off)
IGBTX turns on and IGBTU turns off.
When IGBTX is turned on (gate signal is on), the positive current flows through IGBTX. In this mode, the current becomes larger.

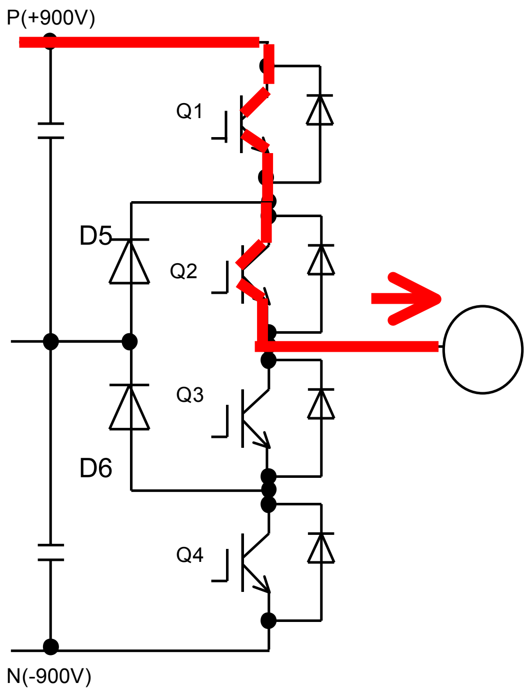
(2) When negative current flows in the power supply (regeneration)
For regeneration, two states a) and b) are controlled by turning on/off the IGBTU and IGBTX in the same way as in motor running operation.

a) IGBTX is turned on (IGBTU off)
IGBTX turns on and IGBTU turns off.
In this case, since IGBTX is on, U-phase output becomes the negative potential (-340V output). Then the current flows through the loop that starts from the virtual neutral point and returns to the virtual 0V of the converter through the power supply.

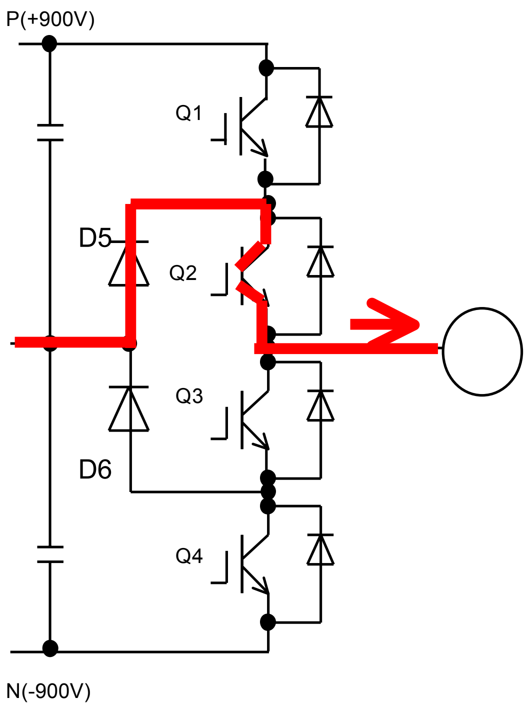
b) IGBTU is turned on (IGBTX off)
IGBTU turns on and IGBTX turns off.
In this case, the current is controlled through IGBTU (340V output). Then the current flows the loop that starts from the virtual neutral point and returns to the virtual 0V through the power supply.
Positive current and negative current may sometimes flow through IGBT and may sometimes flow through diodes. However, the voltage is the same in both cases. That is, when IGBTU gate signal is on, the voltage becomes 340V and when IGBTX gate signal is on, the voltage becomes –340V.

5.1.3 Main Circuit Operation for Three-level Inverter

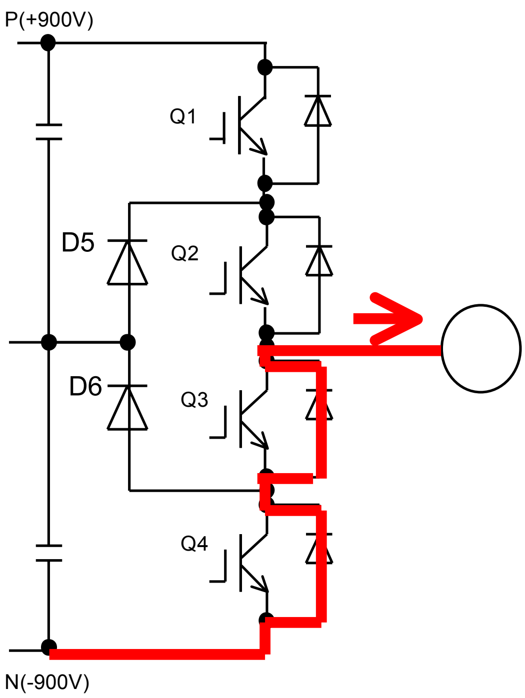
Fig. 5.1.5 and Fig. 5.1.6 show the main circuit operation for the three-level IGBT inverter.



(1) When Q1 and Q2 are ON (positive current)

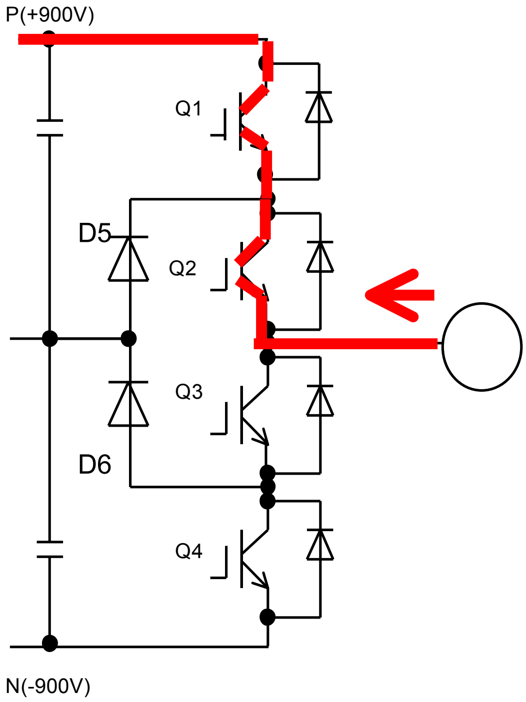


(2) When Q2 and Q3 are ON (positive current)

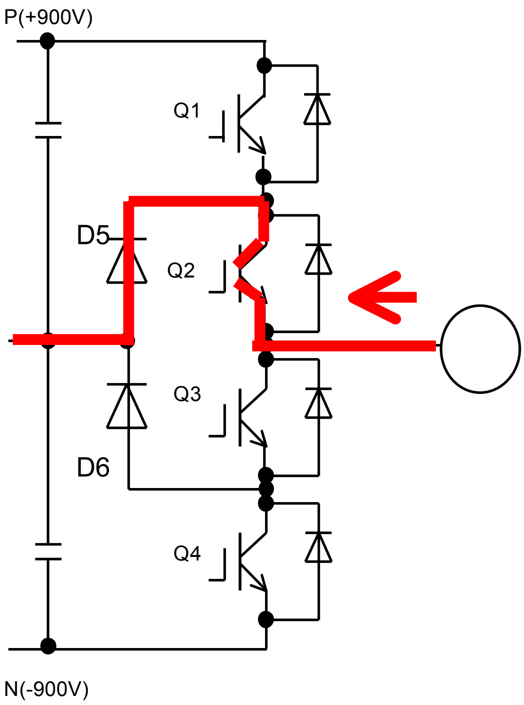


(3) When Q3 and Q4 are ON (positive current)

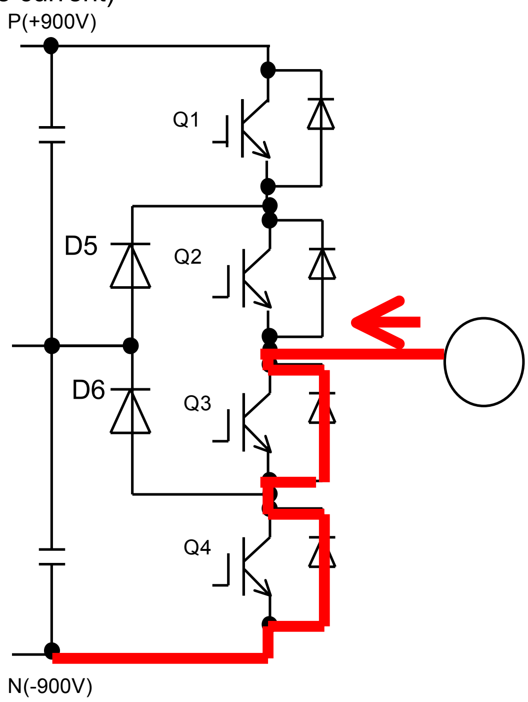
Fig. 5.1.5 Main Circuit Operation for Three-level Inverter



(4) When Q1 and Q2 are ON (negative current)



(5) When Q2 and Q3 are ON (negative current)



(6) When Q3 and Q4 are ON (negative current)

Fig. 5.1.6 Main Circuit Operation for Three-level Inverter

In the three-level inverter, three levels of voltage (P-potential, C-potential, and N-potential) can be output by turning on/off four IGBTs from 01 (IGBT1) to 04 (IGBT4). Fig. 5.1.7 shows the inverter output (phase) voltage waveform and IGBT status. Fig. 5.1.8 shows the output voltage (rectangular wave) and average voltage (sine wave) of the inverter.

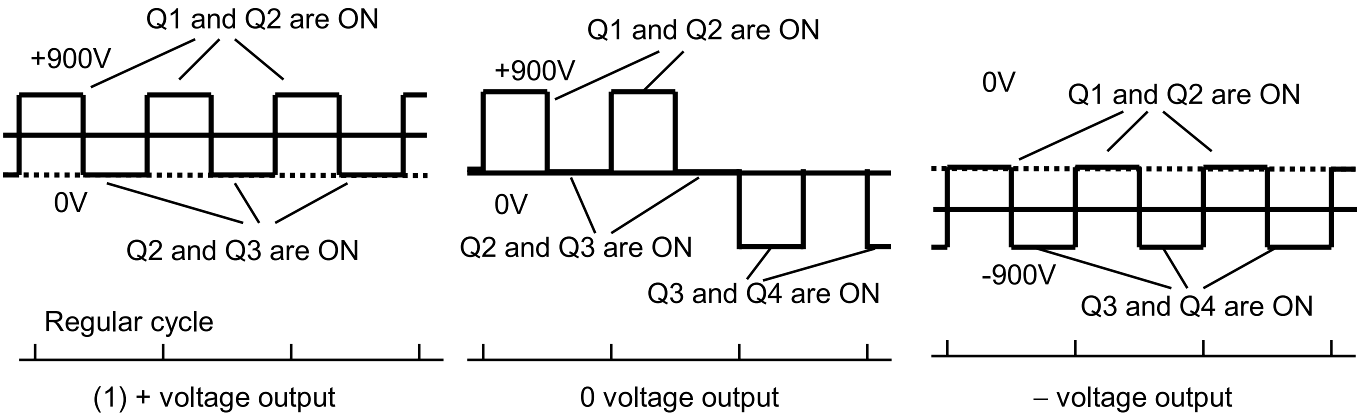


Fig. 5.1.7 Average Output Voltage

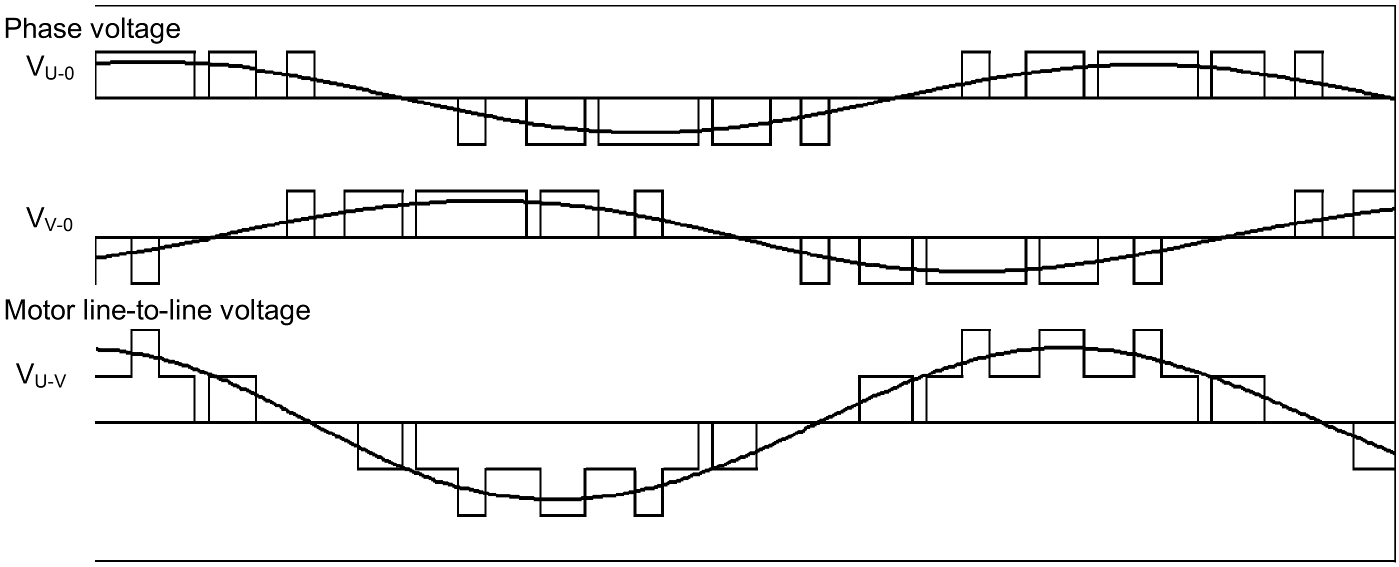
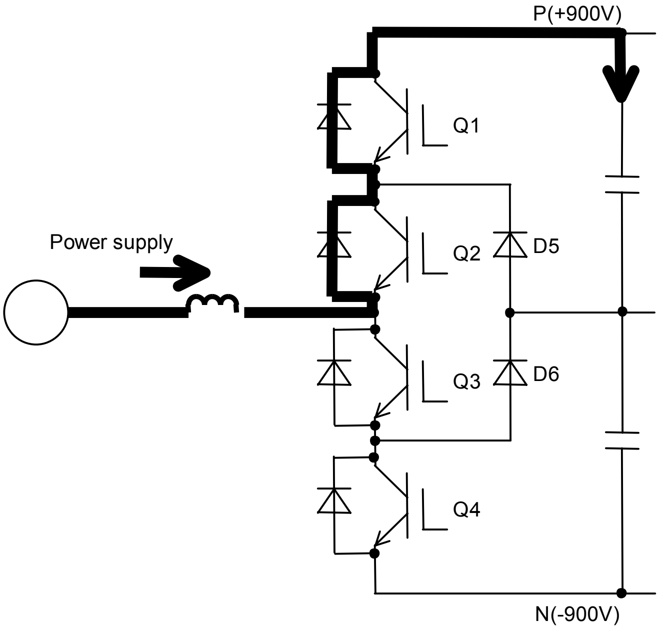


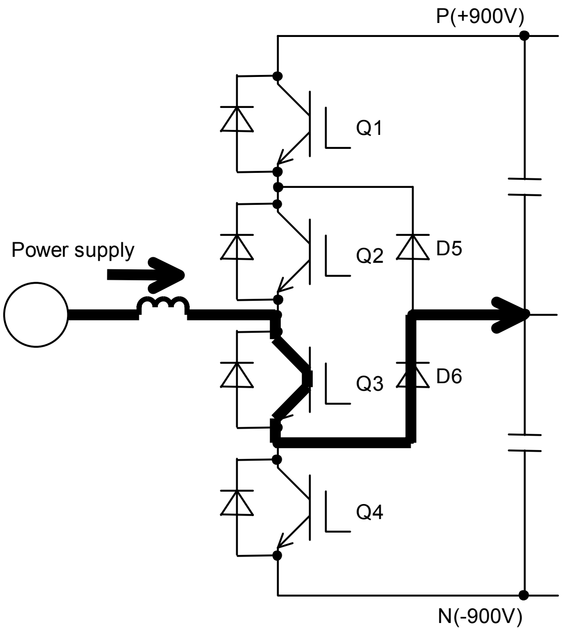
Fig. 5.1.8 PWM Waveform of Three-level Inverter

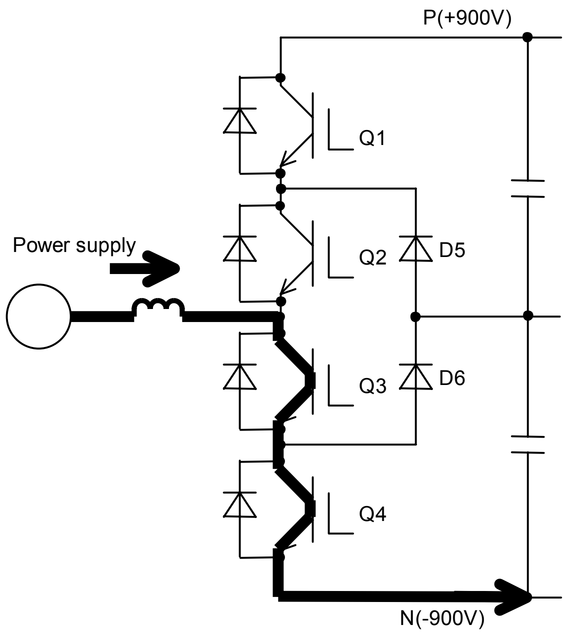
5.1.4 Three-level Converter Operation

Fig. 5.1.9 and Fig.5.10 show the main circuit operation principle for the three-level IGBT converter.



(1) When Q1 and Q2 are ON (positive current)

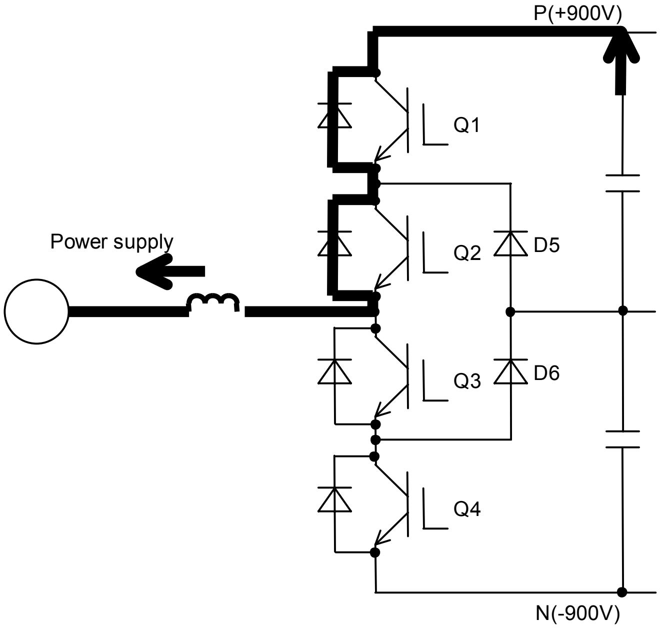




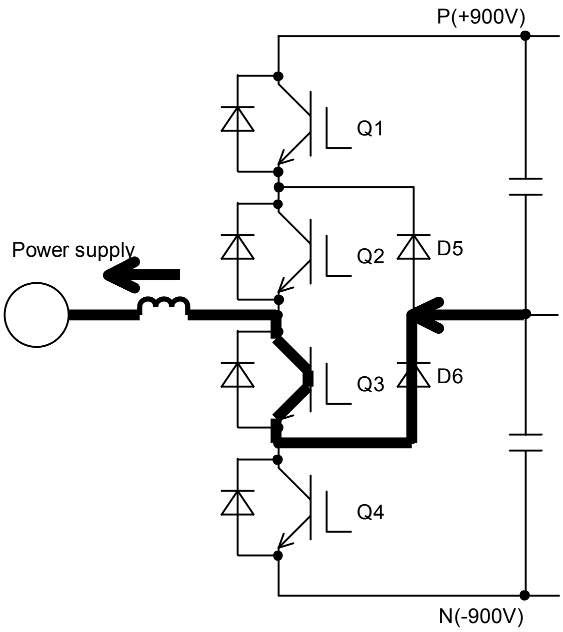
(2) When Q2 and Q3 are ON (positive current)

(3) When Q3 and Q4 are ON (positive current)

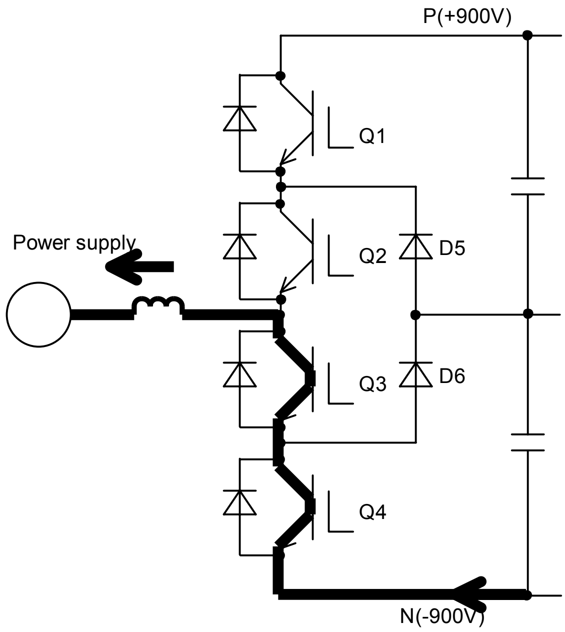
Fig. 5.1.9 Main Circuit Operation for Three-level Inverter



(4) When Q1 and Q2 are ON (negative current)



(5) When Q2 and Q3 are ON (negative current)



(6) When Q3 and Q4 are ON (negative current)

Fig. 5.1.10 Main Circuit Operation for Three-level Converter

In the three-level converter, three levels of voltage (P potential, C potential, and N potential) can be output by turning on/off four IGBTs from 01 (IGBT1) to 04 (IGBT4).

5.2 Main Circuit Configuration of TMdrive-30

5.2.1 Single Drive (1500kVA, 2000kVA)

Fig. 5.2.1 shows the circuit configuration of Cabinet type.

The DC power is supplied from the external DC main power supply to the main circuit through the common bus at the lower portion of the enclosure, and then converted by the inverter into 3-phase AC power necessary to drive the motor (frequency, voltage, and current are controlled).

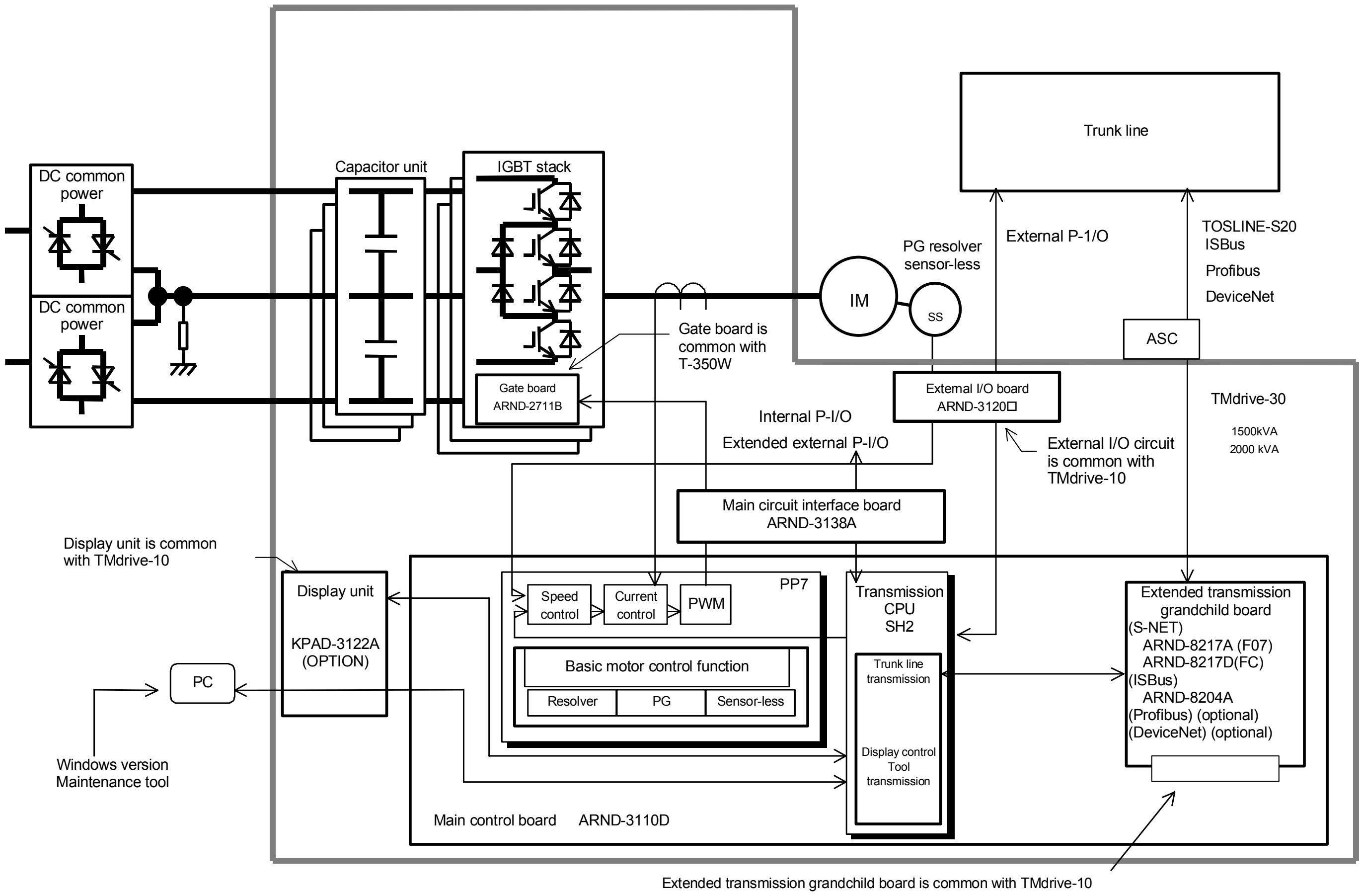


Fig. 5.2.1 Wiring Diagram of TMdrive-30 Control (Single:1500kVA, 2000kVA)

The main circuit is composed of a capacitor and an inverter that converts the DC power into AC power. Basically, the capacitor is intended to temporarily store reactive power of the induction motor. The IGBT unit consists of three phase IGBT stacks, and the output power is supplied to the motor.

Hole CTs (HCTU and HCTW) are provided on the U-phase and W-phase outputs as current detectors.

5.2.2 Twin-drive (2x1500kVA, 2x2000kVA)

Two-winding motor is used. The motor is insulated by two windings to control two sets of main circuits. There are two inverter main circuits available, 2x1500kVA and 2x2000kVA.

The same phase of two winding sets is controlled by one control circuit board.

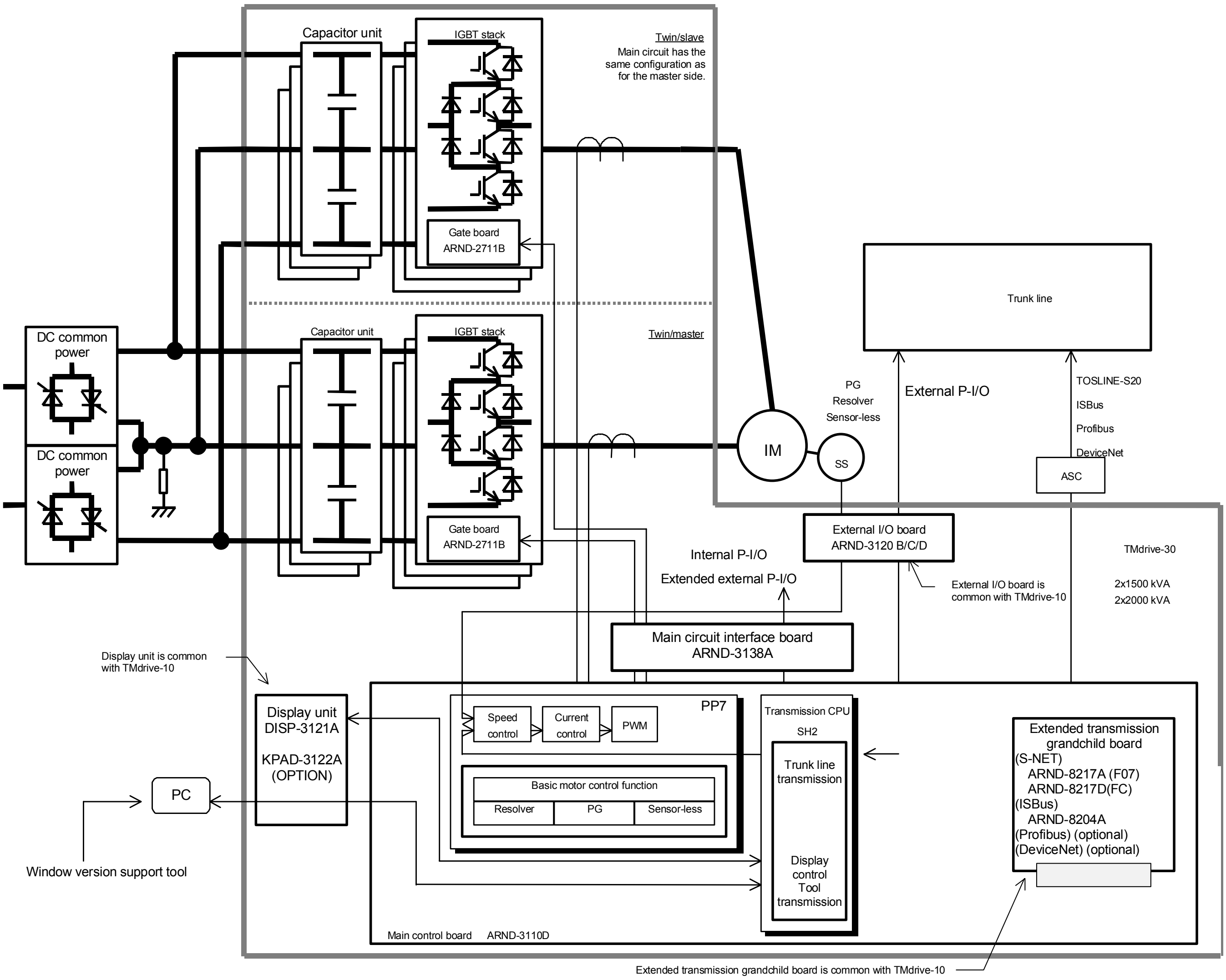


Fig. 5.2.2 Wiring Diagram of TMdrive-30 Control (2x1500kVA, 2x2000kVA)

5.3 Main Circuit Configuration of TMdrive-P30

5.3.1 Single Converter (1700kW)

The main circuit configuration of TMdrive-P30 is described below. As shown in Fig. 5.3.1, 1100Vac is input through the input transformer. IGBT converts this 1100Vac to 2x900Vdc, which is then supplied to the IGBT inverter from a common bus at the bottom of the enclosure.

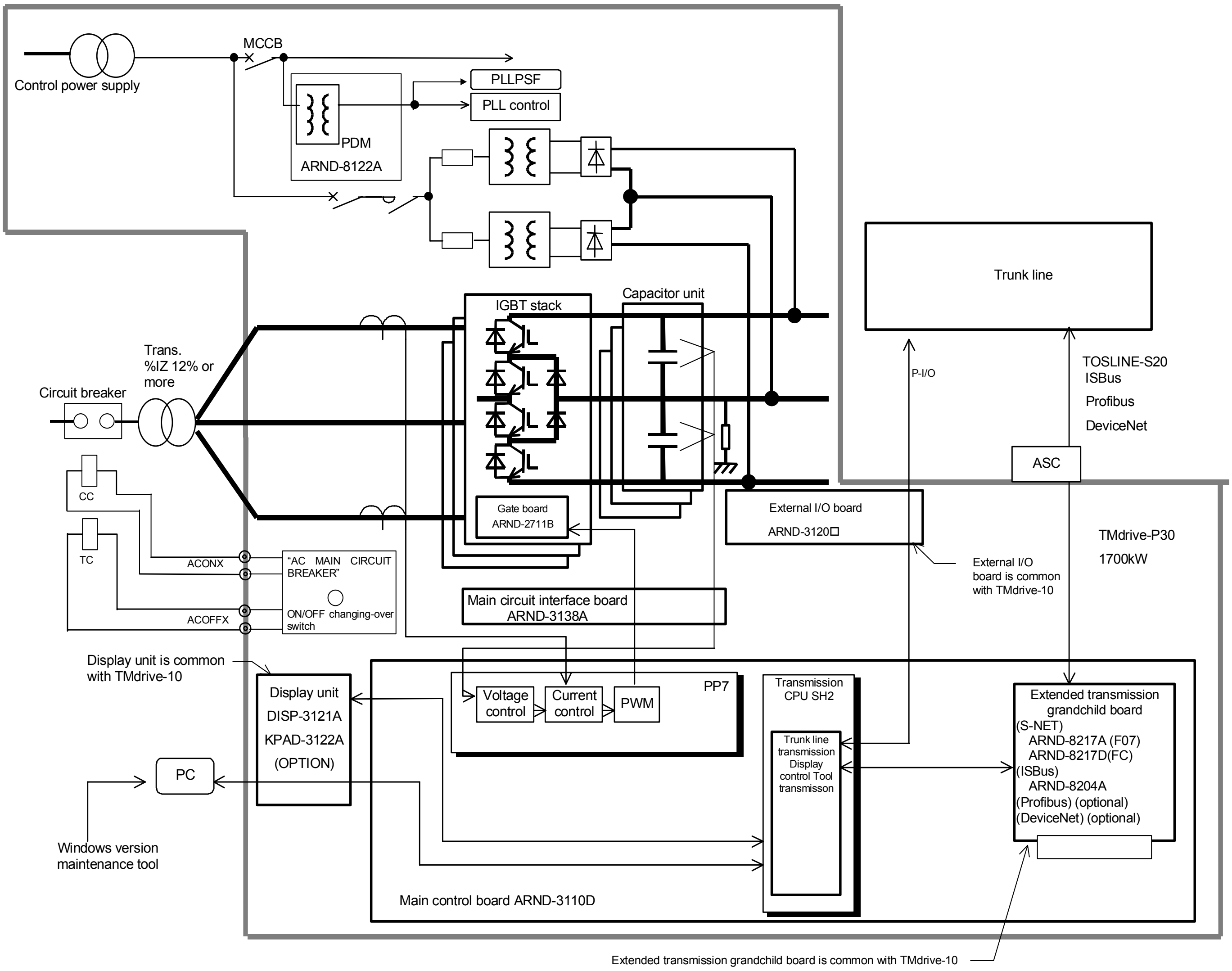


Fig. 5.3.1 Basic Configuration

5.3.2 Twin converter (2x1700kW)

The twin-converter consists of two pairs of converter main circuits that are connected in parallel, as shown in Fig. 5.3.2. IGBT converts the input power to 2x900Vac, which is then supplied to the IGBT inverter from a common bus at the bottom of the enclosure.

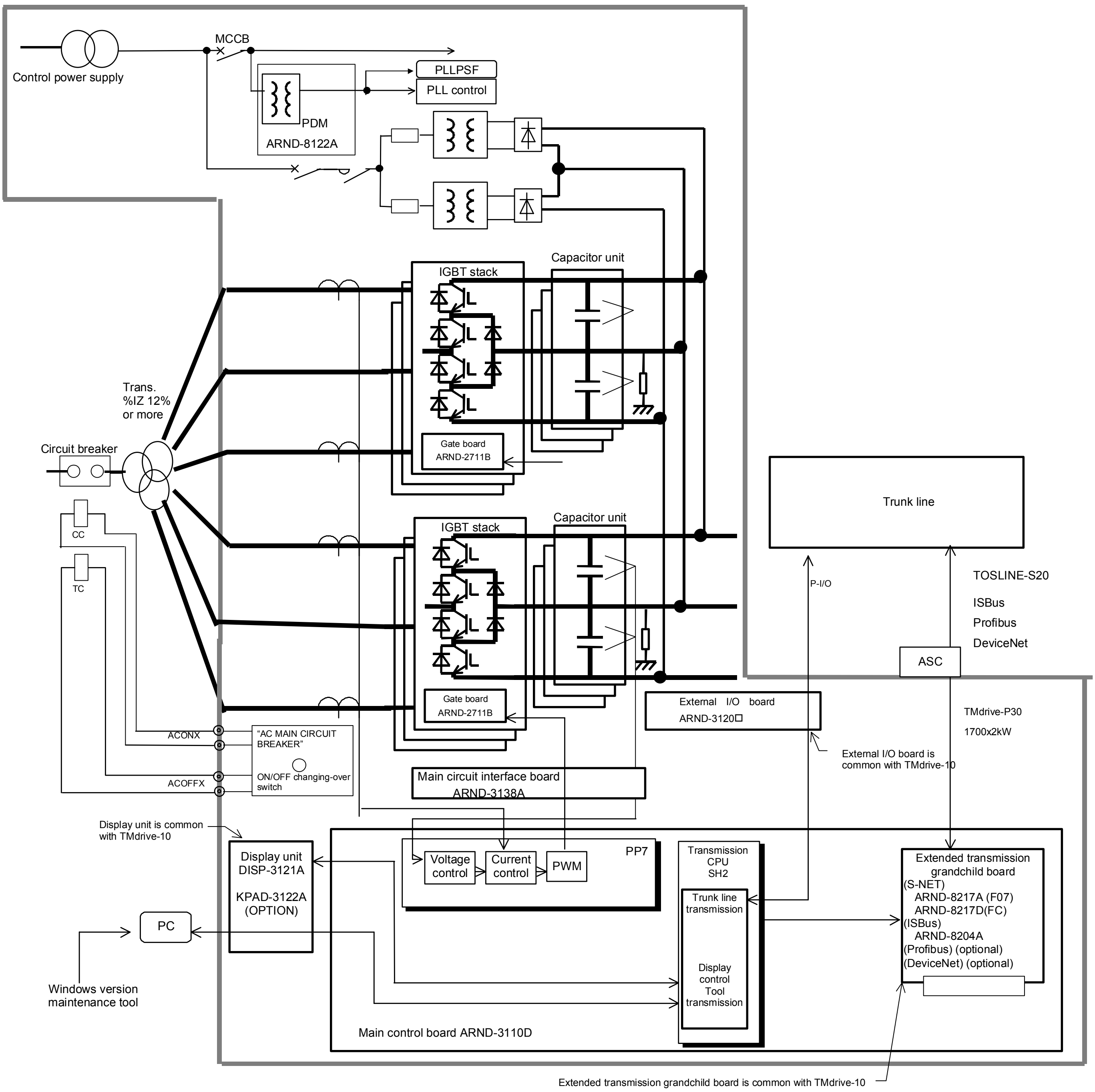


Fig. 5.3.2 Two-bank Converter Configuration

5.4 Control Circuit TMdrive-30

Fig. 5.4.1 shows the TMdrive-30 control block diagram.

$ mark shows a setting parameters. $ mark is only for reference and the actual parameter does not include $. These parameters must set properly.

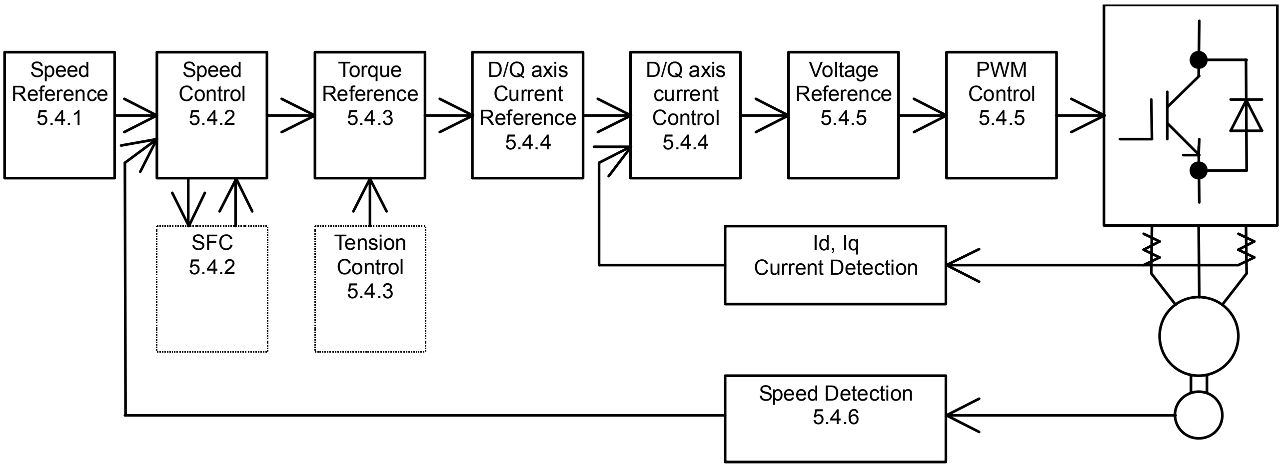


Fig. 5.4.1 Control Block Diagram

5.4.1 Speed Reference

An external speed reference with 25000 counts/100% weighing is input to SP_REF1 through the serial transmission or analog input, and then the rate and limit processes are performed to output the SP_R signal. The speed reference signal is positive for forward rotation and negative for reverse rotation.

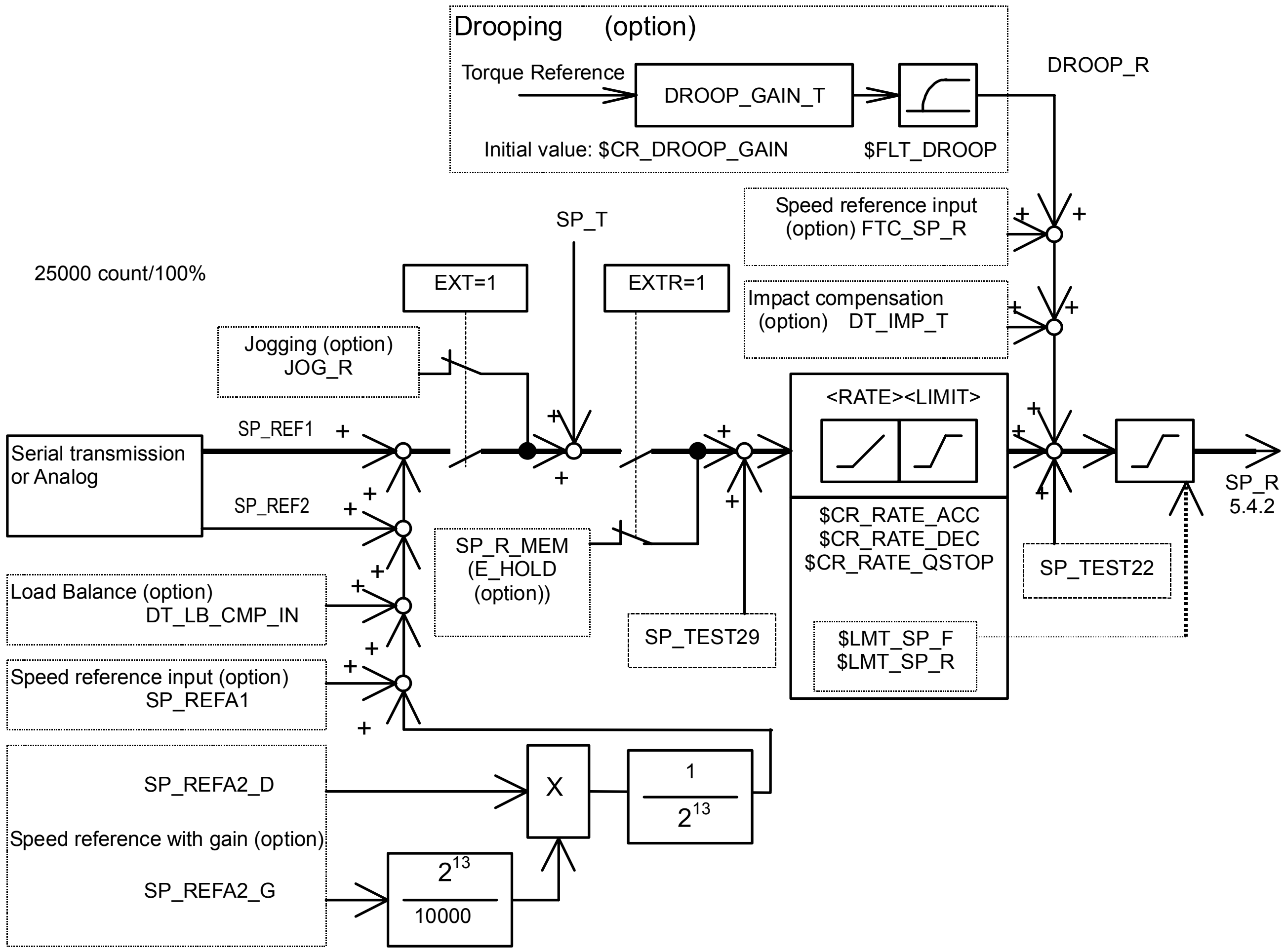


Fig. 5.4.2 Speed Reference

(1) SP_REF2 (option)
This is an auxiliary speed reference input. SP_REF1 is used as a main speed reference signal and correction signal is input to SP_REF2. Both signals are added and used as speed reference for operation. These signals are input through the serial data transmission or analog input.

(2) SP_REFA2_D, SP_DEFA2_G (option)
These signals are used to add a gain to the speed reference input.
The weight of SP_REFA2_G is gain 1 at 10000 counts.
<Example> When the line speed reference is input to SP_REFA2_D and (1/roll diameter) data to SP_REFA2_G, the line speed is converted into the motor RPM by the drive unit.

(3) Drooping (option)

This optional function is used when transferring or machining one material by multiple drive units. In such applications, when the speed of one motor is increased, a large load is applied to this motor and the load applied to other motors is decreased. On the contrary, if the speed of one motor is decreased, the load applied to other motors is increased.

This drooping function decreases the speed reference in proportion to the load if the torque reference (load) increases. If the drooping function is installed in the system consisting of multiple drive units, the speed of the motor, to which a large load is applied, is decreased to make the load applied to each motor balanced. This drooping function is useful to make the load balanced, but may cause the speed control accuracy to lower. Therefore, always pay special attention to the gain when using this function. To improve the speed control accuracy, the drooping gain is changed from the PLC. At this time, the gain is input to DROOP_GAIN_T.

5.4.2 Speed Control

5.4.2.1 Speed Control 1 (ASPR)

Fig. 5.4.3 shows the speed control 1 (ASPR) block diagram.

Speed reference signal SP_R and the speed feedback are input with count 25000/100% weighting and the deviation between these two is subjected to proportional/integral operations and output. After this signal is subjected to speed filtering and torque limit processing, its torque reference SFC_T_R is output with count 4000/100% weighting.

Control response is performed with the following parameter settings.

$ASPR_A: Anti-overshoot gain
Setting this parameter to a large value can reduce excessive overshoot.
$ASPR_AT: Anti-overshoot time constant
Adjust this parameter to reduce overshoot.
$ASPR_P: Proportional gain
This parameter is set by GD^2 and target response.
$ASPR_W1: Response target
This parameter sets the target response with 0.01 rad/s unit.

Note that if GD^2 of the machine is extremely large compared to GD^2 of the motor or if there is axial resonance, the control response may not be increased.

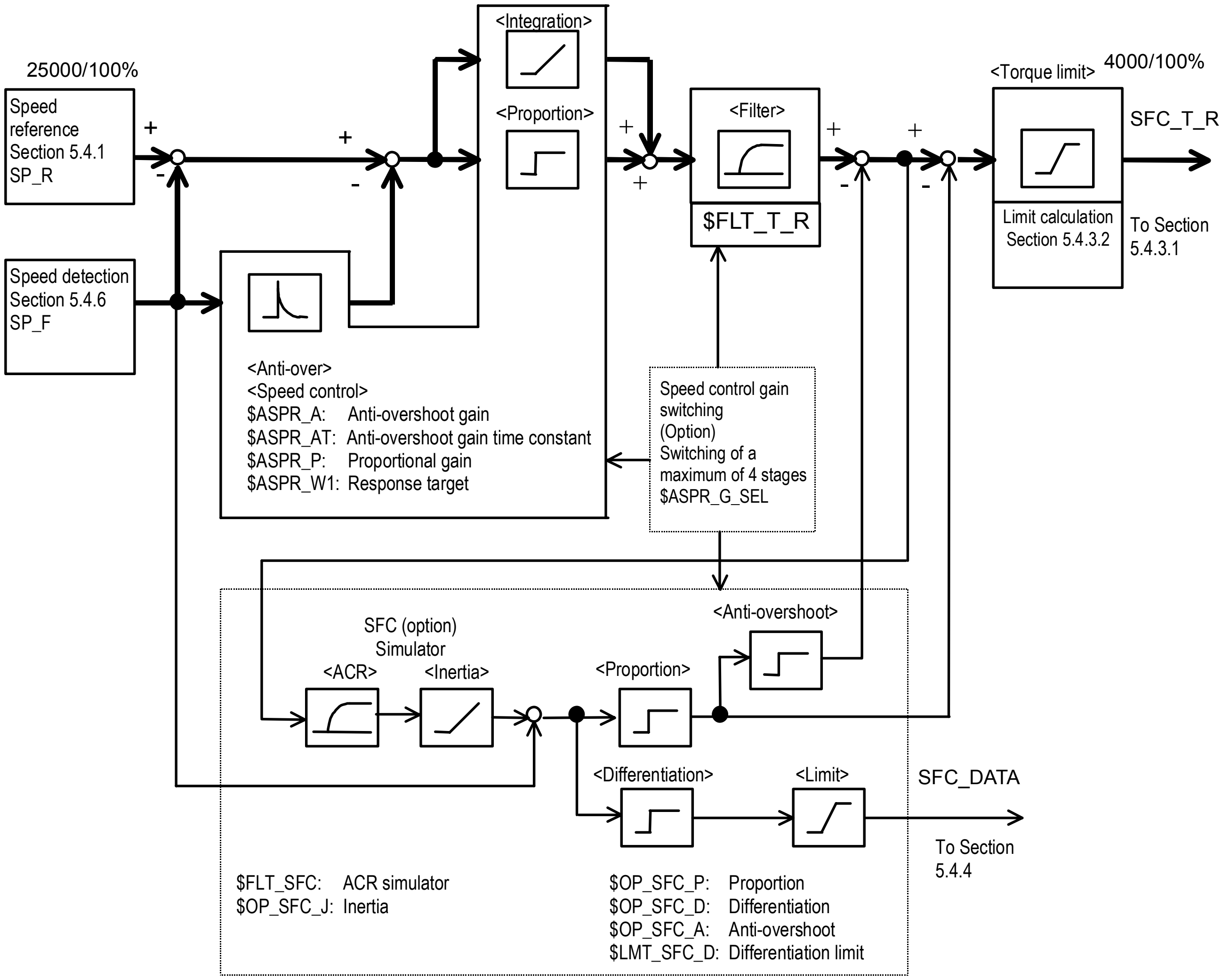


Fig. 5.4.3 Speed Control

5.4.2.2 Speed control gain switching (option)

The speed control response is determined relative to load GD^2. Therefore, as load GD^2 fluctuates a great deal (such as winder), the speed response changes (as GD^2 grows with the same gain, the response slows down). For such a case, this equipment is provided with a function to keep the operation stable by using different speed control gains.

a) 4-stage switching
In this mode, the equipment is operated by switching 4 sets of speed control gains which were preset through an external signal.
$ASPR_G_SEL: Set 1 when switching speed control gain.
ASPR_G_NO: Input the speed control gain set number. (0 to 3)
If there is any difference between the speed reference and actual speed, a shock is perceived at the moment the gain is switched.
Try to switch the gain in a stationary state (when the speed is stable).

b) Continuous gain
This function changes the gain continuously through an external signal.
$ASPR_G_SEL: Set 2 for continues switching of speed control gain.
ASPR_GAIN_EXT: Externally changed speed control gain. Gain 1 with 100.
ASPR_GAIN_EXT is limited to a value between 100 and 30000. In other words, the gain control function operates in a direction in which the gain is increased. This function is used by presetting a gain when GD^2 is a minimum and adjusting the gain externally so that it is increased with respect to the preset gain.

(1) Simulator following control (SFC, option)
When the machine axes resonance, the simulator following control (SFC) function is available.

a) Simulator
With the SFC, a speed control output signal is input and an acceleration torque signal (simulation) is obtained by the ACR simulator. This signal is input to the inertia simulator to obtain an estimated speed signal.
ACR simulator: First order lag operation
Inertia simulator: Integral operation

b) Deviation
Calculates the deviation between the above estimated speed signal and actual speed signal.

c) Proportion
The above deviation signal is subjected to gain operation processing and added to the speed control result. This proportional output is effective for the improvement of recovery response to an impact load generated by biting of rolling material.
In normal speed control, the speed control output becomes a (load torque + acceleration torque) reference. Adding SFC control makes the load torque signal an output from the SFC proportional term, while the speed control output becomes equivalent to the acceleration/deceleration torque reference. Because of this, the acceleration torque signal is obtained by the ACR simulator as shown in a) above.

d) Differentiation
The above deviation signal is differentiated and added to the torque reference.
This signal is effective for vibration control.
When the SFC function is not used, set each gain of SFC to 0.

5.4.2.3 Speed Control 2 (ASR)

Fig. 5.4.4 shows the speed control 2 (ASR) block diagram.

The speed control circuit receives the speed reference signal SP_R and the speed feedback signals at the weight rate of 25000 counts/100% and the deviation of these two proportional calculation outputs, and the integral calculation result of the deviation of these two signals are output. This control operation works when $FLG_ASR=1 is set. The control response is made with the following parameter settings.

$ASR_P_CMD:	Speed reference proportional gain	
$ASR_P_FBK:	Speed feedback proportional gain	
$ASR_I:	Integral gain	Target response x 0.5 is normally set.
$ASR_ERR_MAX:	Error deadband max. value	These are used when the speed control error deadband detection is used to select the tension control & the speed control 2 (ASR) in the torque control mode.
$ASR_ERR_MIN:	Error deadband min. value	
$ASR_W0:	Speed control response gain	Target response x 2 is normally set.
$ASR_J0:	Speed control inertia gain	

When the machine's GD^2 is much larger than the motor's GD^2 or if the shaft resonance occurs, control response may not be improved to higher level.

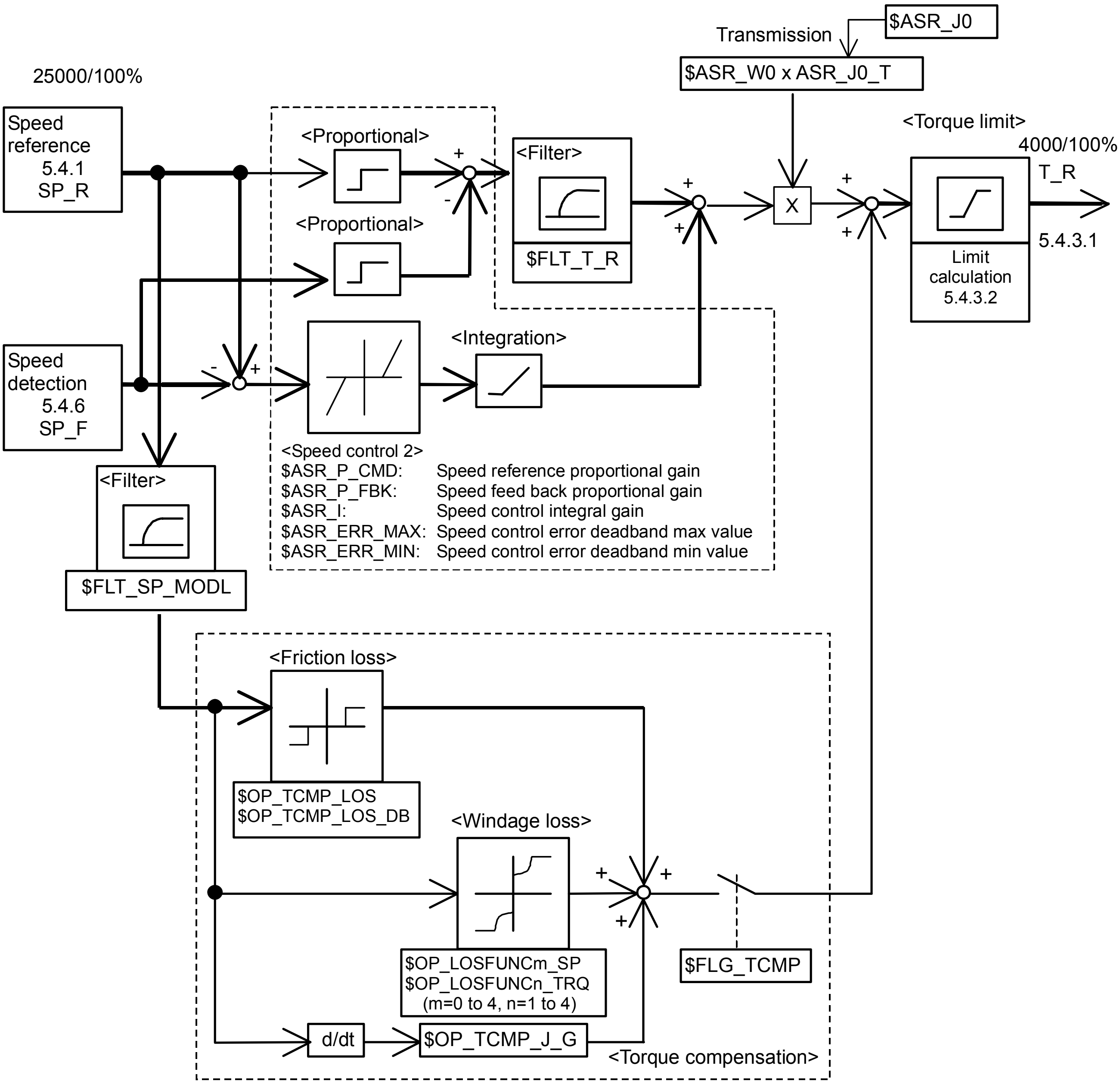


Fig. 5.4.4 Speed Control 2

5.4.2.4 Speed Control with RMFC Control (ASRR)

Fig. 5.4.5 shows the speed control block with RMFC control (ASRR).

The speed reference signal SP_R and speed feedback SP_F are entered with a weight of 25000 count/100%. The difference between SP_R and SP_F is proportionally integrated and output. After this signal is processed with a speed filter and torque limit, the torque reference SFC_T_R is output with a weight of 4000 count/100%.

Control response is performed by the following parameter setting:

$ASPR_A:	Anti-overshoot gain	If overshoot is large, it can be suppressed by setting a large value.
$ASPR_AT:	Simultaneous constant	Regulate so as to reduce overshoot.
$ASPR_P:	Proportional gain	Set by GD^2 and target response
$ASPR_W1:	Response target	Set target response in the unit of 0.01rad/s.

Note that, if machine GD^2 is excessively larger than the motor GD^2 or if there is shaft resonance, control response may not be set high.

When RMFC control is used, anti-overshoot gain $ASPR_A and simultaneous constant $ASPR_AT are not used, so set 0 to both $ASPR_A and $ASPR_AT.

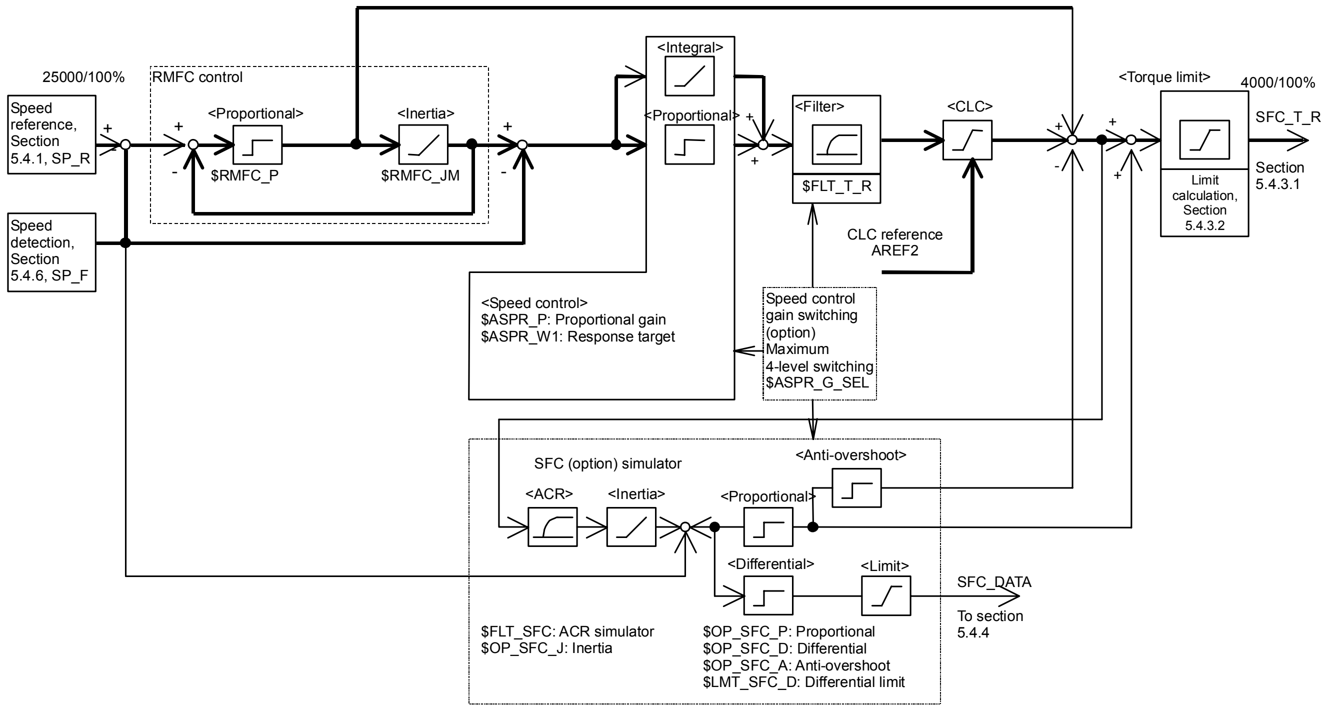


Fig. 5.4.5 Speed Control (ASRR)

(1) RMFC: Reference Model Following Control
RMFC control consists of the following:
   (1) A machine model where the system is approximated to an ideal one-inertia system.
   (2) A speed controller that controls the machine system model.

This control system is called “Reference Model Following Control (RMFC) “because the motor speed is controlled so that it will follow the model speed output from the reference model.
By combining RMFC control with speed control that comes after, it is possible to configure a two-degree-of-freedom control system where the speed reference response and disturbance response can be set separately.

(2) Variable current limiter control (CLC, option)
When performing tension control or torque control of load, it is possible to perform current control according to the external reference (variable current limiter control (CLC)).
When performing CLC, enter ST signal (See Section 3.5.1) from outside and enter CLC reference by analog input or transmission input. In this case, increase the external speed reference to the speed limit to saturate the speed control output.

For speed control gain switching and SFC, see Section 5.4.2.1.

5.4.3 Torque Reference and Current Reference

Signal SFC_T_R equivalent to the torque reference, which is the speed control results, is input to calculate the torque limit and process di/dt in order to calculate the final torque reference signal T_R.

5.4.3.1 Tension Control (Option)

If optional tension control is used, the TRQ_REF signal obtained from the calculation results of the speed control is compared with the tension reference TENS_R signal input externally to find the torque reference. In this optional control, operation is made based on TENS_R used as torque reference during normal operation and the speed control circuit functions as speed limit. (Operation is made based on the external torque reference in winding machines. However, if materials are broken, operation is changed to the speed control operation.)

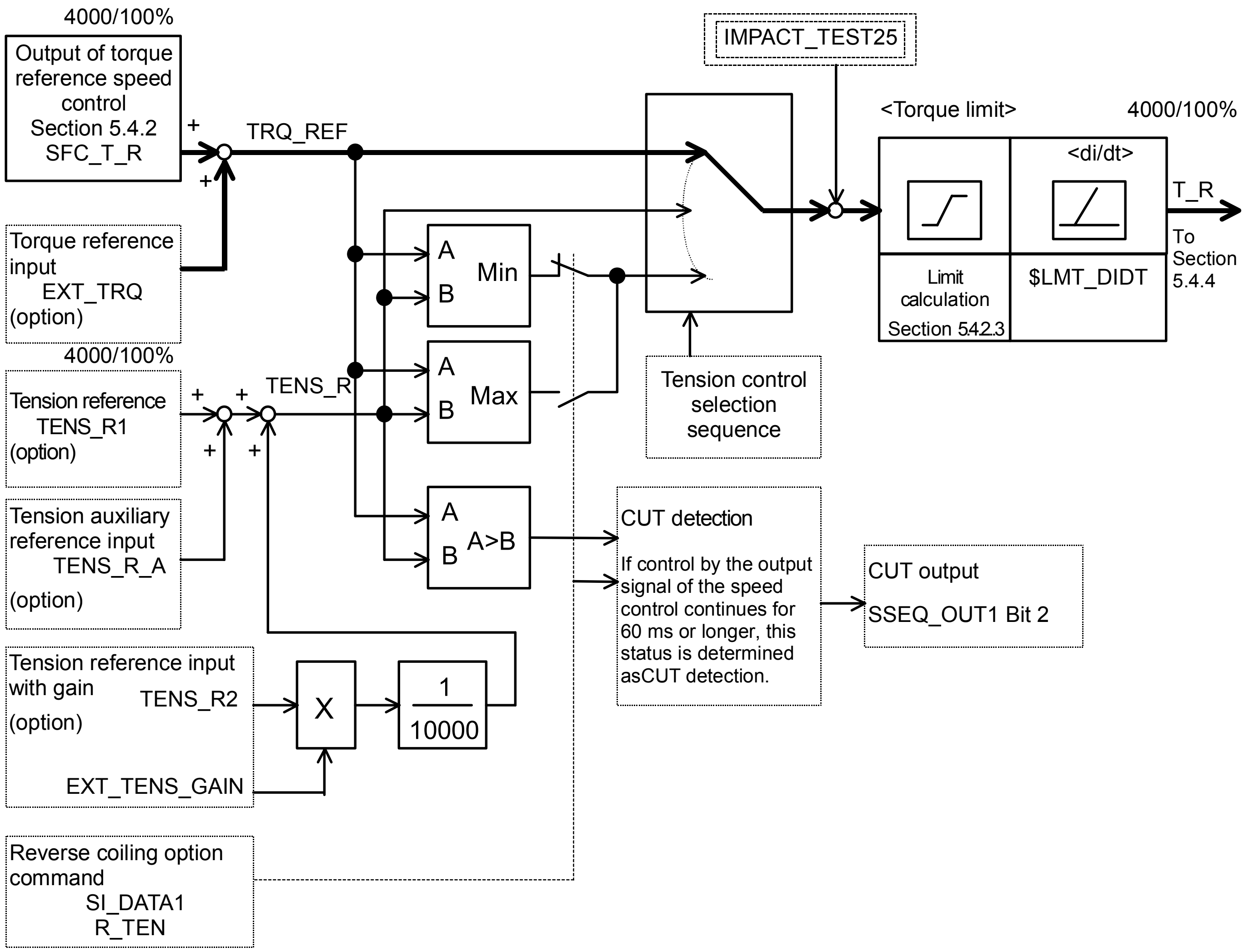


Fig. 5.4.6 Torque Reference

5.4.3.2 IQ Limit

The IQ limit has a flat characteristic as a standard, but as shown in Fig. 5.4.7, it can also be set according to the speed and operating conditions.

(1) Standard setting
The IQ limit has the following settings and flat characteristic.
The graph in the figure shows this characteristic.
$LMT_IQ_BAS: Set 2000 (200%), etc. according to OL specification.
$LMT_IQ_TOP: Set the same value as the value above.
$LMT_IQ_INV: Set the same value as the value above.
$LMT_SP_BASE: Set 1000 (100%).

(2) Speed rate
At a speed set by $LMT_SP_BASE or lower, the IQ limit is $LMT_IQ_BAS and it is a value on a straight line between point ($LMT_SP_BASE, $LMT_IQ_BAS) and point (100% speed, $LMT_IQ_TOP) at higher speed.
It is also possible to set the IQ limit during regenerative operation.
$LMT_IQ_BAS: Set the IQ limit at a speed specified by $LMT_SP_BASE or lower.
$LMT_IQ_TOP: Set the IQ limit at 100% speed.
$LMT_IQ_INV: Set the IQ limit during regenerative operation.
$LMT_SP_BASE: Set 1000 (100%).

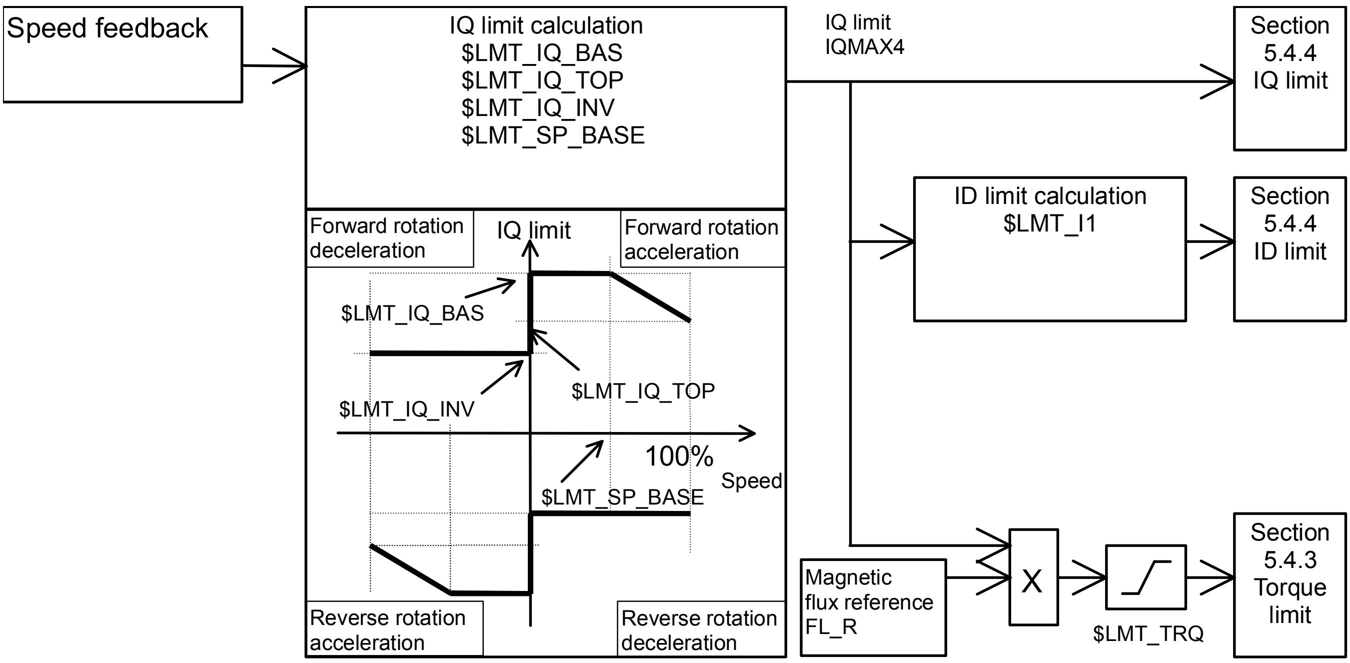


Fig. 5.4.7 IQ Limit

5.4.4 D-Q Axis Current Control

Fig. 5.4.7 shows the block diagram of D-Q axis current control.

This system controls the current of an induction motor by separating it into a torque component and magnetic flux component. This system controls the current on the D-Q coordinates and can handle both reference and feedback values as DC values. This means that it can control the current from an AC motor as a DC value, achieving high performance control irrespective of output frequencies.

(1) IQ control
The torque reference which is the result of the aforementioned speed control is input and divided by magnetic flux to obtain an IQ reference. This IQ reference and IQ feedback signal are input and proportional integral operations are carried out on them. An induction voltage compensation and L compensation are added to this result to obtain an EQ reference.

(2) ID control
A magnetic flux reference is obtained according to the speed reference and an ID reference corresponding to this magnetic flux is obtained. This ID reference and ID feedback signal are input and a proportional integral operation is carried out. The L compensation is added to this result to obtain an ED reference.

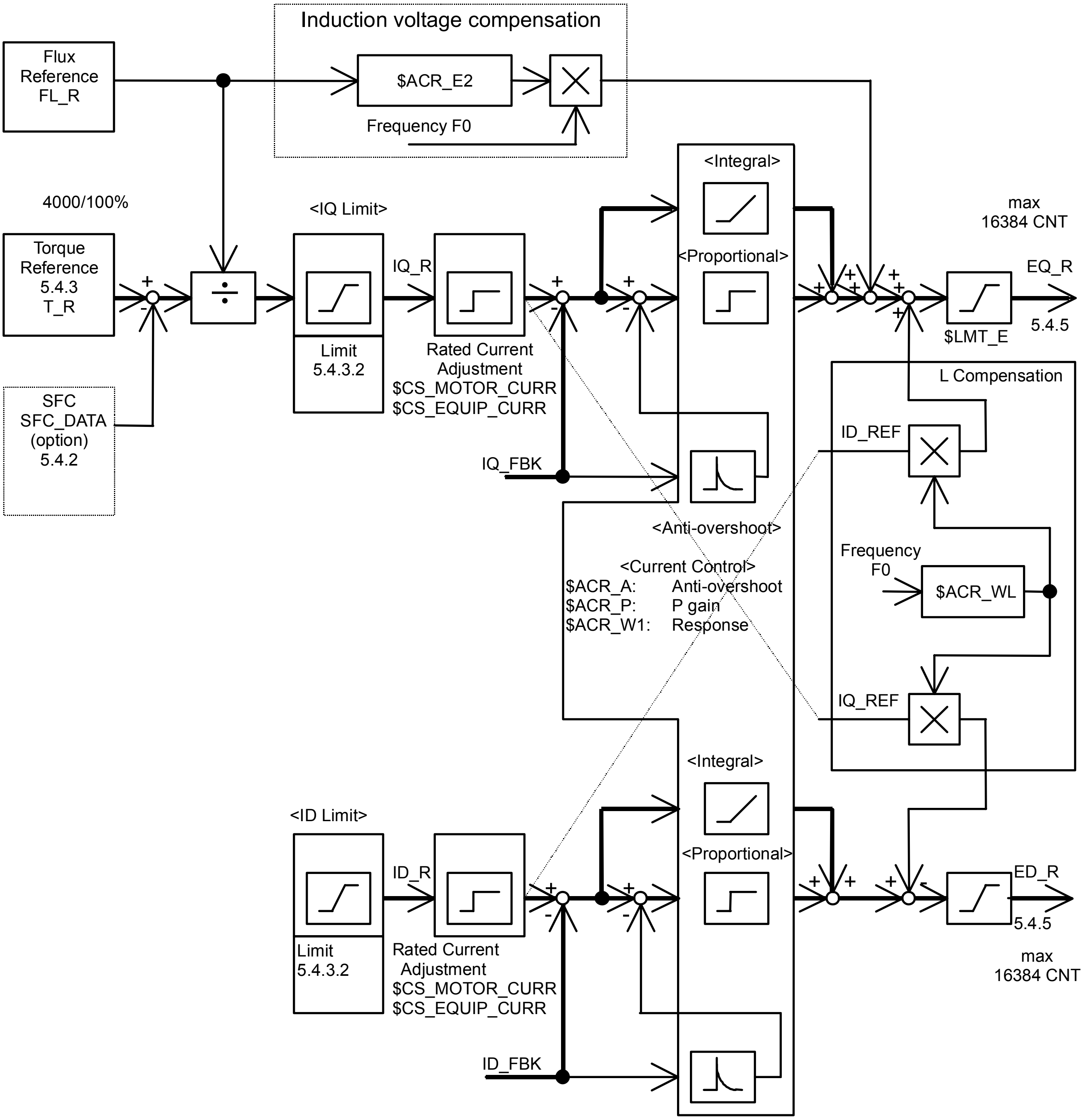


Fig. 5.4.1 D-Q Axis Current Control

5.4.5 Voltage Reference

(1) Voltage reference
EQ_R and ED_R, the results of current control, are input. Then, θ, the information of magnetic flux, is input and a 3-phase voltage reference is obtained. Since in this case an interval is provided between ON and OFF of the IGBTs, a dead time compensation is inserted. Furthermore, another compensation is inserted for when the output voltage of a specific phase is saturated to output the voltage reference for PWM control.

(2) PWM control
The PWM control section outputs gate pulse signals based on the voltage reference of each phase.

(3) Gate board
The gate board insulates gate signals generated by the PWM section and amplifies them to drive the IGBTs.

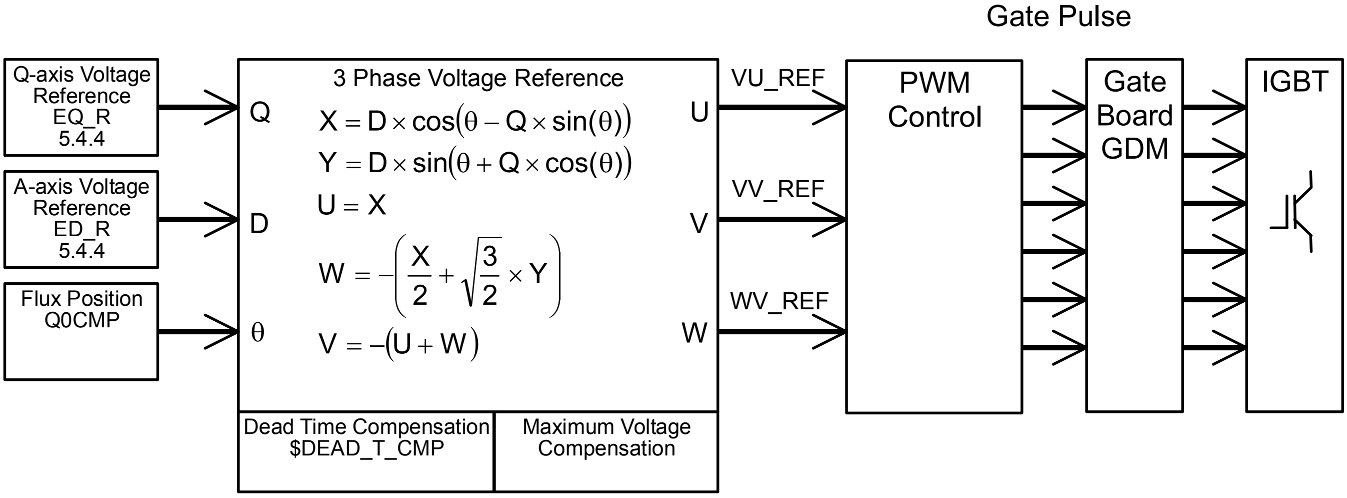


Fig. 5.4.2 Voltage Reference

(4) Dead time compensation
In Fig. 5.4.2, the IGBTU and IGBTX are inserted in series between the "+" and "-" sides of the DC power supply.

If both the IGBTU and IGBTX, are on at the same time, the DC power supply is shorted, causing an overcurrent to flow in the IGBTU and IGBTX, which may destroy the main circuit. Moreover, the IGBT has a nature that its on-state operation is quick, while its off-state operation is relatively slow. Therefore, on/off control of the IGBTs works in such a way that when one IGBT is turned off, another IGBT is turned on after a certain wait time. This wait time is called dead time.

Providing this dead time prevents DC short-circuits. However, this control prevents the desired voltage from being output in the control circuit. This is why the dead time compensation is provided. However, the Toshiba decides the settings and the user must not change them.

5.4.6 Speed Feedback

A PLG (Pulse Generator) or a resolver can be selected for speed feedback (for details of the interface, see section 3). Speed control with a TG is not provided because its performance is inferior.

5.4.6.1 PLG

A signal is detected from a 2-phase PLG attached to the motor and converted to a speed.

Detection is basically performed according to the pulse number measurement system. This system converts a signal to a speed based on the fact that the pulse number inputted in a period (1ms) is proportional to the speed.

Since in this system, pulse signals from the PLG do not change at an extremely low speed or 0 speed, stable speed detection is not possible. When it is necessary to operate the equipment for such a purpose (passing 0 speed in reversible operation has no problem), use a resolver.

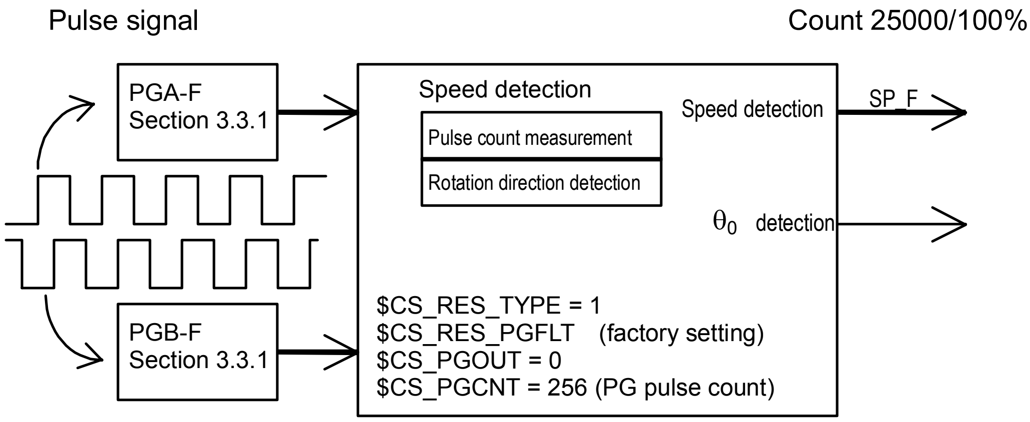


Fig. 5.4.3 PLG Speed Detection

5.4.6.2 Resolver

A resolver is a sensor that detects the rotating angle (position) of the motor. This resolver converts changes in position into speed signals at periodic intervals.

Two types of resolvers are available, 1x type and 4x type.

(1) 1x type
This type of resolver detects one electrical rotation as the motor rotates one rotation. This resolver is used for relatively high-speed motors.

(2) 4x type
In this resolver, the number of resolver phases is increased. This resolver detects one electrical rotation as the motor rotates 1/4 rotation. This resolver is used for low-speed motors (1000 min^{-1} or less).

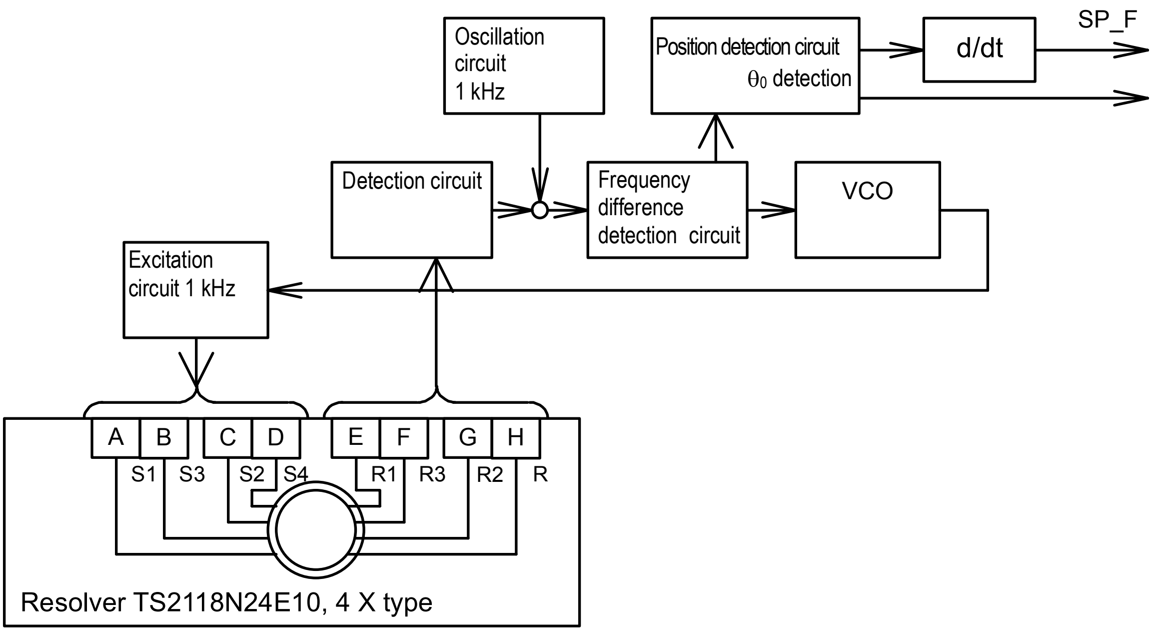


Fig. 5.4.4 Resolver Speed Detection

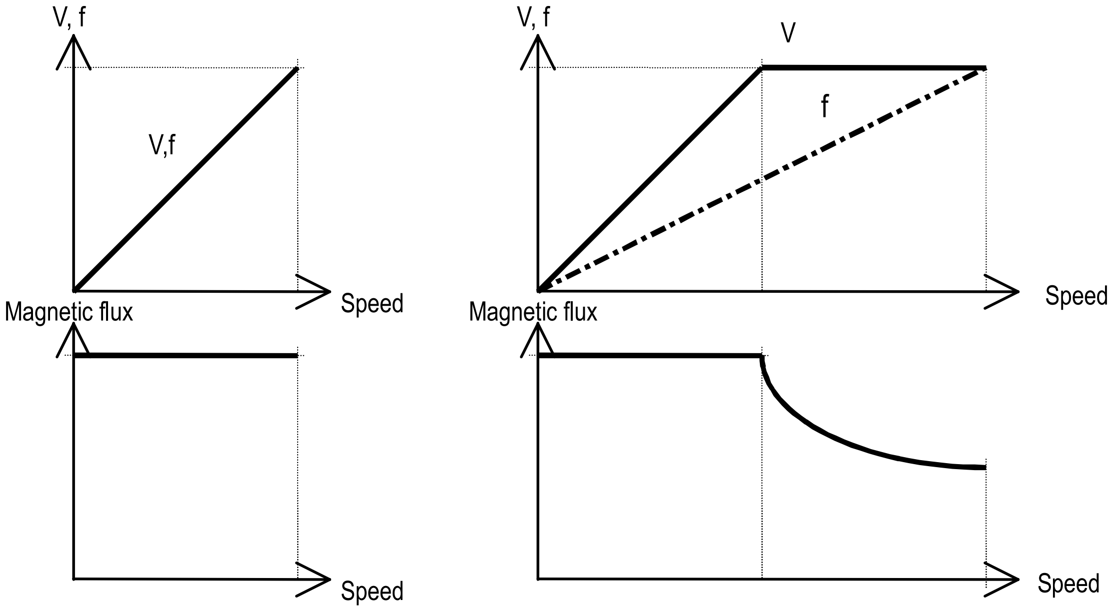
5.5 Optional Function According to Application (TMdrive-30)

5.5.1 Auto Field Weakening Control

Operation shown in Fig. 5.5.1 a) to make the magnetic flux constant is used for general operation method of the induction motor. In TMdrive-30, operation is performed with the magnetic flux and ID_REF made constant. At this time, the induced voltage is calculated by multiplying the speed by the magnetic flux. The voltage is then increased in proportion to the speed.

In the auto field weakening control, when operating at a higher speed, the induced voltage is controlled at a constant level based on the magnetic flux reference in inverse proportion to the speed feed back after the voltage has reached the rated voltage.

If the speed exceeds the start speed of the field weakening control, the induced voltage becomes constant and the motor output shows the constant output characteristics. (Fig. 5.5.1 b))



a) Constant magnetic flux b) Field weakening control

Fig. 5.5.1 Field Weakening Control Characteristics

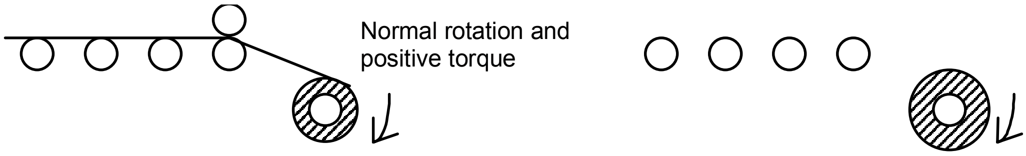
5.5.2 Torque Control

In winding machines, the winding materials are controlled at a specified tension. Therefore, the host PLC calculates the torque (reference) to be output from the motor. Additionally, the drive unit controls to output a torque corresponding to this torque reference. Furthermore, operation is made with speed control when the winding is completed or winding of next materials is started.

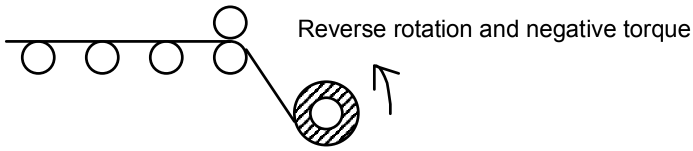
On the other hand, if operation based on the torque reference sent from the host PLC continues in case of a fault, such as material breakage, overspeed may result. In such case, the control is automatically changed to the speed control. (Torque control with speed limit function)

When using this torque control, set $FLG_TENSEL to “1”.

The following describes how to use the torque control for operation with normal rotation and positive torque.



a) Winding (tension control and normal winding)   b) After winding (speed control)



c) Winding (reverse winding)

Fig. 5.5.2 Tension Control

(1) Speed control

To operate with speed control, the speed reference corresponding to the line speed is input in the same manner as described for normal operation.

When the EXT sequence signal is turned on and ST sequence signal is turned off, the speed control is started.

(2) Torque control (with speed limit function)

As the operation preparation completed (READY) and operation command (EXT) signals are on, the torque control selection (ST) signal is turned on. After that, the TRQ_REF signal is compared with the external torque reference TENS_R1 signal. External torque reference TENS_R1, whichever is smaller, is detected by the logic that picks up the minimum value, and then used as the torque reference T_R signal.

When performing the torque control with the speed limit function, the speed reference signal, which is approximately 5% higher than the line speed, is input from the host PLC. As a result, the speed reference 5% higher than the actual speed is input and the TRQ_REF single showing the speed control calculation result is saturated by the positive torque limit value. The external torque reference is then used for control.

(If operation is made with the external torque reference, the motor is actually operated at a speed equivalent to the line speed. As the speed reference is increased 5%, the speed deviation always becomes positive, causing the speed control calculation result to increase to the limit value.)

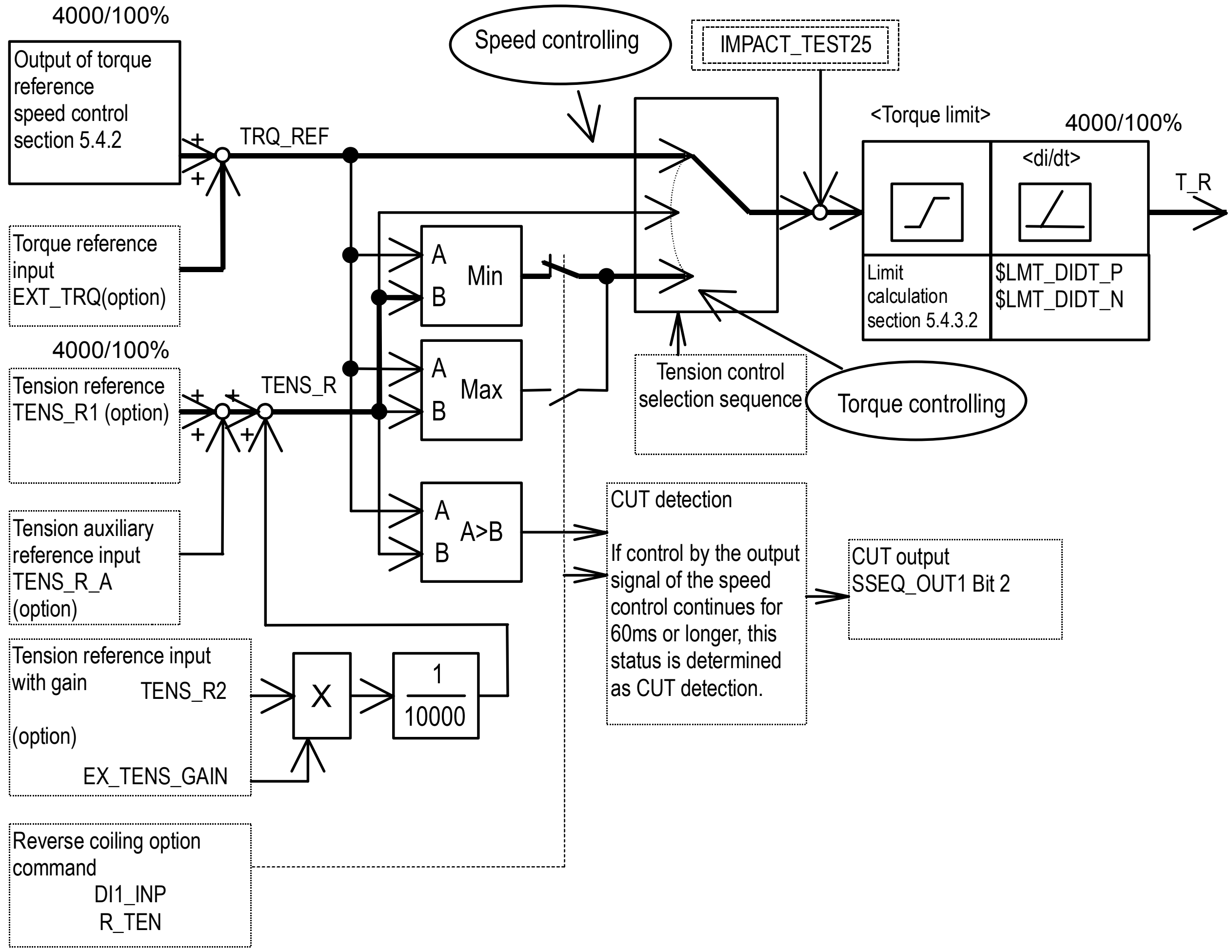


Fig. 5.5.3 Torque Control

(3) Speed limit operation

If operation continues with the external torque reference even though materials are broken in the torque control, the motor is accelerated. If the speed is accelerated to a level 5% or more higher than the line speed, the saturation status of the speed control is cancelled. The TRQ_REF value becomes small and this signal is then used for control. That is, the control is changed to the speed control.

(4) Cut detection

This detects that the operation is changed to the speed limit operation. When the control with the speed control output signal (speed control) continues for 60 ms or longer, the cut signal is output. However, this cut signal is used for the host PLC. Even though this signal is detected, the control state on the drive unit is not changed.

(5) Reverse winding option

There are two winding directions, normal winding and reverse winding, as shown in Figure Fig. 5.5.4 a) and c). A desired winding direction is selected using the normal winding/reverse winding switch (R_TEN).

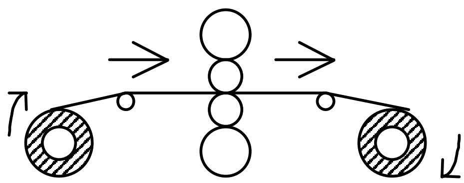
R_TEN: 0 = Normal winding
1 = Reverse winding

The TRQ_REF signal with the polarity is compared with the external torque reference TENS_R1 signal with the polarity. By the logic picking up the maximum value, the larger external torque reference TENS_R1 is used as the torque reference T_R.

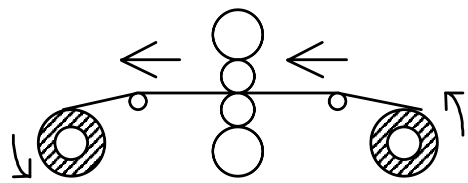
Table 5.5.1 shows the polarity of each control amount.

Table 5.5.1 List of Polarities in Torque Control

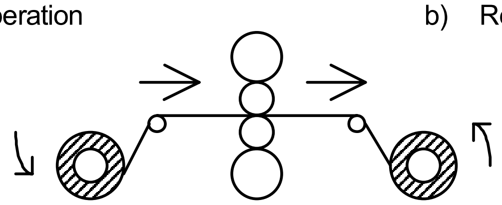
	Coiling direction	External speed reference	Speed bias	Speed feedback	Tension reference	Operation mode
Payoff reel	Normal winding (Normal re-winding)	-	+	-	+	Reverse deceleration
	Reverse winding (Reverse re-winding)	+	-	+	-	Normal deceleration
Tension reel	Normal winding	+	+	+	+	Normal acceleration
	Reverse winding	-	-	-	-	Reverse acceleration



a) Normal operation



b) Reverse operation



c) Reverse winding operation

Fig. 5.5.4 Normal and Reverse Winding Operations

5.5.3 Sensor-less Vector Control

This sensor-less vector control performs the vector control of the induction motor without use of the speed sensor. Conventionally, there has been the V/f control without the speed sensor. However, this sensor-less vector control provides the simple control feature of the V/f control and the high performance of the vector control. The following describes the features of the sensor-less vector control.

(1) Sensor installation and wiring construction are not required.

(2) This control is applicable to motors, in which the sensor cannot be installed, such as two-axis motors or super high-speed motors, and other motors, which require special sensors, such as explosion-proof motors.

(3) This vector control technology is used for parallel drive of multiple motors, which is difficult to control by the conventional vector control.

(4) This sensor-less vector control provides excellent stability and large start-up torque when compared to the V/f control.

(5) The torque can be limited, ensuring stable rapid acceleration and deceleration.

5.5.4 V/f Control

The restrictions described in Section 3.3.3 are imposed to the multiple motor parallel drive method by sensorless vector control. Especially pay attention to the following restrictions:

- The change in the number of motor units can be allowed up to 50%.
- Motors can be added during operation only when the operation speed is 30% or slower and the number of units to be added does not exceed 50% of the connected units.

With these restrictions, in sensorless control, since “voltage is output, as a result of controlling current”, excessive change in the number of units may cause a transient instability, which can result in equipment stop.

Whereas, V/f control is less affected by external disturbance such as a change in the number of units, since “voltage is output according to frequency.”

Consequently, it is recommended to use V/f control for purposes where fast response is not critical and the change in the number of motor units exceeds the restriction described above.

5.5.5 JOG Operation

JOG operation is a mode that operates the inverter while JOG command is inputted, and has the following features.

(1) Forward output by forward JOG command (F), reverse output by reverse JOG command (R).
(2) The 1st speed, 2nd speed and 3rd speed are provided for each forward JOG command and reverse JOG command. Use 2nd speed command (2S) to select 2nd speed and 3rd speed command (3S) to select 3rd speed.
(3) Each F, R, 2S and 3S command is inputted via sequence input or PI/O input.

Also, the function has the following restrictions.

(4) Startup command (EXT) is given priority over JOG command.
In addition, JOG command is detected at the rise of the signal, so JOG operation is not performed even when startup command is turned off after start command cancels JOG operation.
(5) The command which is previously inputted among F and R, 2S and 3S is given priority.

Setting parameters shown in Table 5.5.2 are speed reference of JOG operation. JOG operation command and an operation pattern is shown in Fig. 5.5.5.

Table 5.5.2 JOG Operation Command and Speed Reference Settings

Type	Forward JOG command F	Reverse JOG command R	2nd speed command 2S	3rd speed command 3S	Speed reference setting
Forward JOG 1st speed	1	0	0	0	$CR_JOG_FJ1S
Forward JOG 2nd speed	1	0	1	0	$CR_JOG_FJ2S
Forward JOG 3rd speed	1	0	0	1	$CR_JOG_FJ3S
Reverse JOG 1st speed	0	1	0	0	$CR_JOG_RJ1S
Reverse JOG 2nd speed	0	1	1	0	$CR_JOG_RJ2S
Reverse JOG 3rd speed	0	1	0	1	$CR_JOG_RJ3S

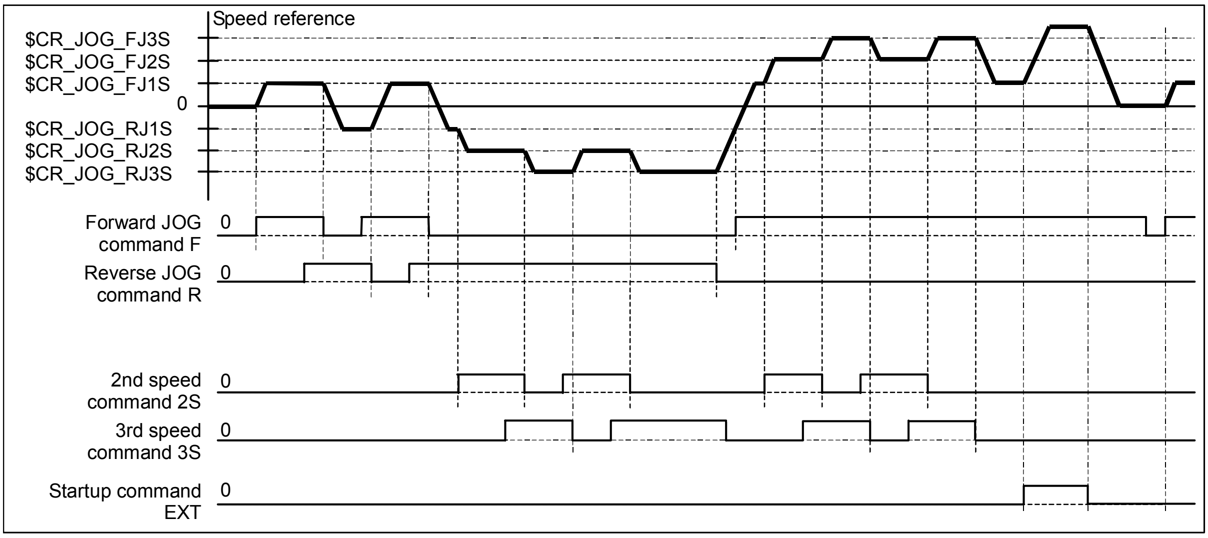


Fig. 5.5.5 JOG Operation Command and Operation Pattern

5.5.6 Emergency Operation

In case of an emergency, the following two kinds of operations can be made by the PI/O signal.

5.5.6.1 Emergency Operation Mode

This operation mode is used to operate the equipment regardless of the signals sent from the TOSLINE-S20 in the system with the transmission unit (TOSLINE-S20). Normally, if a fault occurs in the host PLC of the system operated only with TOSLINE-S20 signals from the host PLC, drives units are operated only with I/O level signals in this mode.

- Contact, which is closed in the emergency operation mode, is connected to the terminal on the input/output circuit board (XIO: ARND-3120).
- Assign this input signal to E-DRIVE signal.
- If the E-DRIVE signal is closed, the sequence data input from TOSLINE-S20 is omitted and operation is made only with P I/O.

In the emergency operation, the sequence input of the P I/O input is mask-processed by $MSK_DI_EMG. Therefore, sequence input signals different from normal operation are input.

5.5.6.2 E-HOLD Mode

In this operation mode, if a fault occurs in the main system, which is being operated, the contact is input to the input/output circuit board (XIO: ARND-3120) to continue operation at a speed, at which the fault has occurred.

- Contact, which is closed by the HOLD operation command, is connected to the terminal on the input/output circuit board (XIO: ARND-3120).
- Assign this input signal to HOLD signal.
- If the external contact input to EXT is closed, the operation is made based on the external reference regardless of HOLD inputs.
- If the external contact input to EXT is opened and external contact input to HOLD is closed, that speed is kept and operation continues based on that speed reference (E-HOLD state).

When stopping operation from the E-HOLD state, the external contact input to HOLD is opened or other operation preparation (UV) conditions are turned off.

5.5.7 Shared Motion

Two kinds of motors can be changed and controlled by one set of inverter. In this case, since the setting parameters which responded with control of each motor is needed, the shared motion which changes setting parameters simultaneously with motor change is used. The outline of the shared motion is shown in Fig. 5.5.6. Setting parameter change signal 2S can be inputted via DI or LAN.

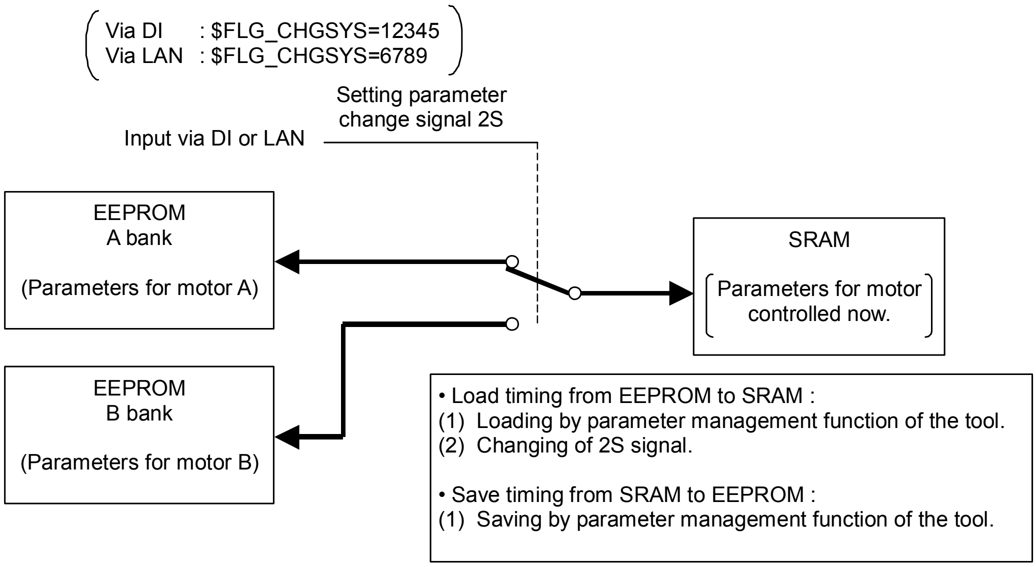


Fig. 5.5.6 Shared Motion

Fig. 5.5.6 shows the setting value switching signal interface. Transmission input or DI signal input can be used for signal input. You can specify whether transmission input is used or DI signal input is used by $FLG_CHGSYS. When the DI signal is used, connect the 2S signal to the input terminal TB2-28 (D17) on the I/O board.

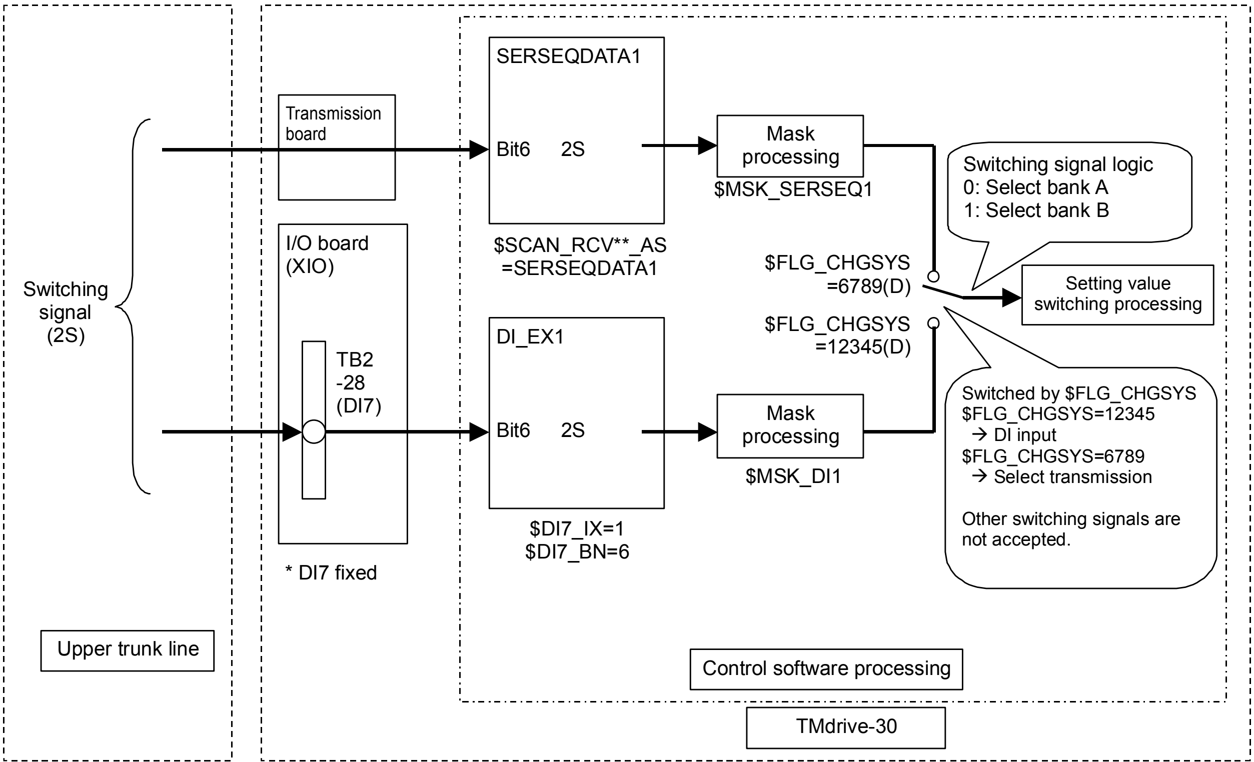


Fig. 5.5.7 Setting Value Switching Signal Interface

The setup of shared motion may not be completed normally at the beginning of adjustment at field. In this case, setting parameter change cannot be performed using 2S signal. Therefore, the method that save parameters to A bank and B bank EEPROM from a setting parameter file at the beginning of adjustment at field is shown in Fig. 5.5.8.

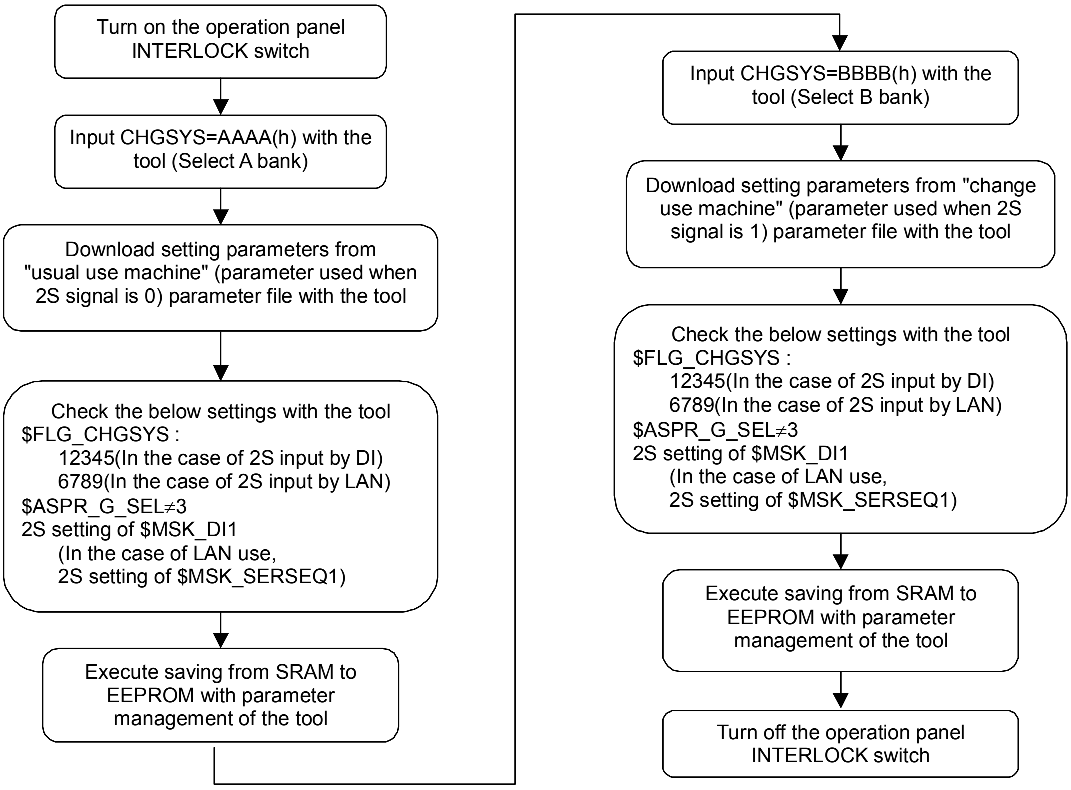


Fig. 5.5.8 The Setting Parameter Save Method to Each Bank of EEPROM

Bit signal B_CPUA_CHG_SET (bit 13 of CPUA_STS1) indicates which bank the inverter is actually selecting. When B_CPUA_CHG_SET is 0, bank A is selected. When B_CPUA_CHG_SET is 1, bank B is selected.

5.6 Control Circuit TMdrive-P30

The figure below shows the TMdrive-P30 control block diagram.

$ mark shows setting parameters. $ mark is only for reference and the actual parameter does not include $.

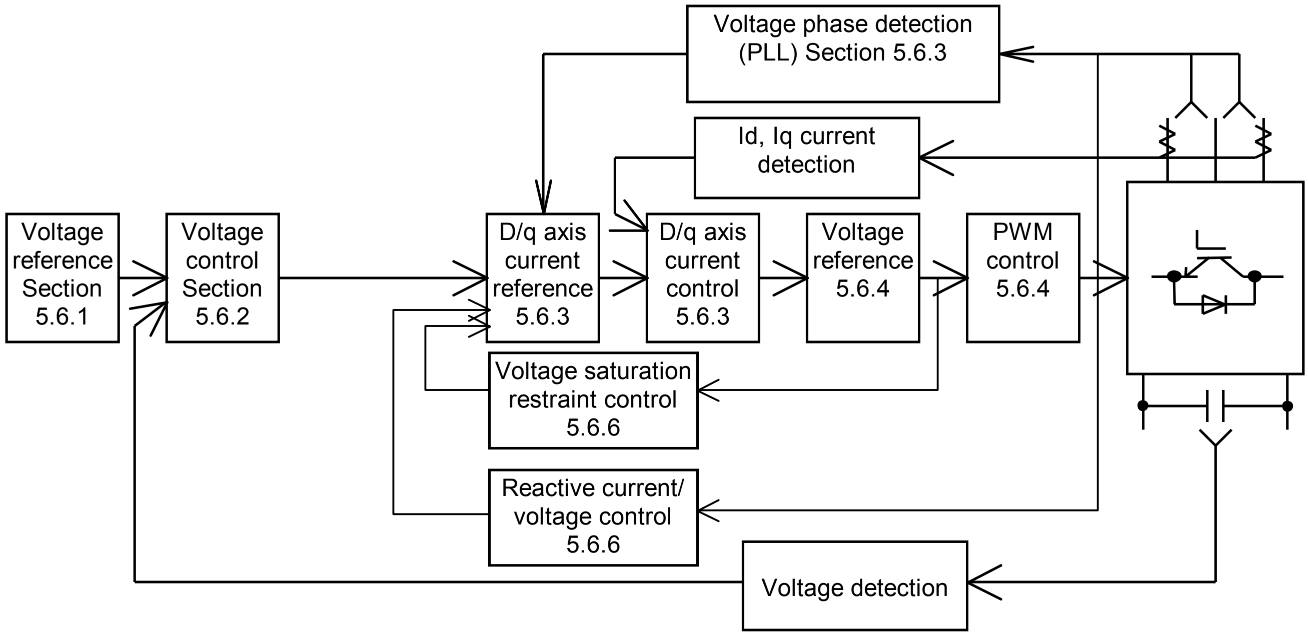


Fig. 5.6.1 Control Block Diagram

5.6.1 Voltage reference

The voltage reference is set for $CW_V_R, with 10000 count/100% weighting. The standard setting is $=_V_R=100%.

5.6.2 Voltage Control

The voltage control block is shown below. The voltage reference signal V_R and voltage feedback VDC_F are input with 10000 count/100% weighting and the deviation between these two is subjected to proportional/integral operations and output. After this signal is subjected to filtering and torque limit processing, IQ_R is output with 4000 count/100% weighting.

Control response is performed with the following parameter settings:

$AVR_A	: Anti-overgain	If the overshoot is large, set this parameter to a large value, which can reduce excessive overshoot.
$AVR_AT	: Simultaneous constant	Adjust this parameter to reduce overshot.
$AVR_P	: Proportional gain	This parameter is set by a load condition and target response.
$AVR_W1	: Response target	This parameter sets the target response with 0.01rad/s weighting.

The control response varies depending on the load condition (the total capacity of the connected inverter capacitor). Be careful that if the number of units connected is changed drastically, control may be unstable.

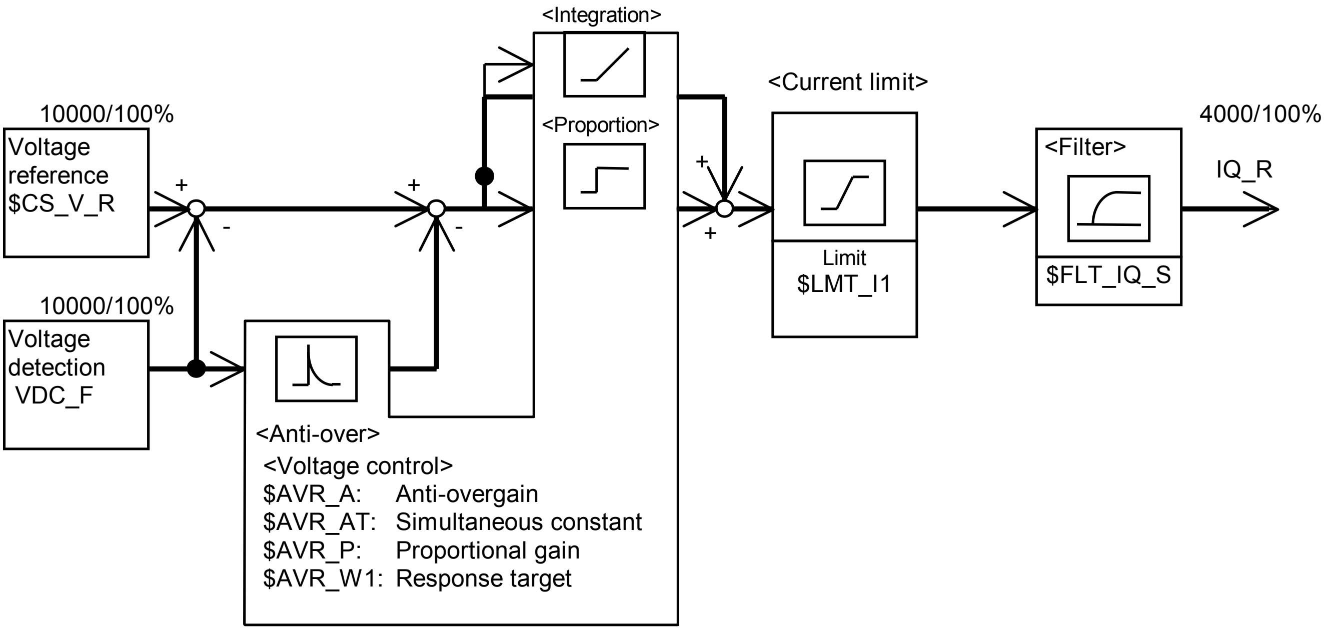


Fig. 5.6.2 Voltage Control Block

5.6.3 D-Q Axis Current Control

Fig. 5.6.3 shows a block diagram of D-Q axis current control.

This system controls power supply current by separating it into active current and reactive current. This system controls current on the D-Q coordinates and can handle both reference and feedback values as DC values. This means that it can control AC as a DC value, achieving high-performance control.

(1) IQ control
The active current reference, which is the result of the voltage control described above, is used as an IQ reference. This IQ reference and IQ feedback signal are input and proportional/integral operations are carried out on them to obtain an EQ reference.

(2) ID control
The reactive current of the power supply is used as an ID reference. This ID reference and the ID feedback signal are input and proportional/integral operations are carried out on them to obtain an ED reference.

(3) Voltage phase detection (PLL)
VD_FBK is obtained from the AD voltage by coordinate conversion. This VD_FBK is input to the proportional integrator and integration is carried out on the output to obtain the phase of the input voltage (CNV_Q0). This CNV_Q0 is used in coordinate conversion for calculating VD_FBK and coordinate conversion for calculating voltage reference.
When CNV_Q0 is identical to the phase of the actual input voltage, VD_FDK becomes “0” logically. That is, here, the phase of the input voltage is detected by performing proportional/integral control so that VD_FBK always becomes “0.”

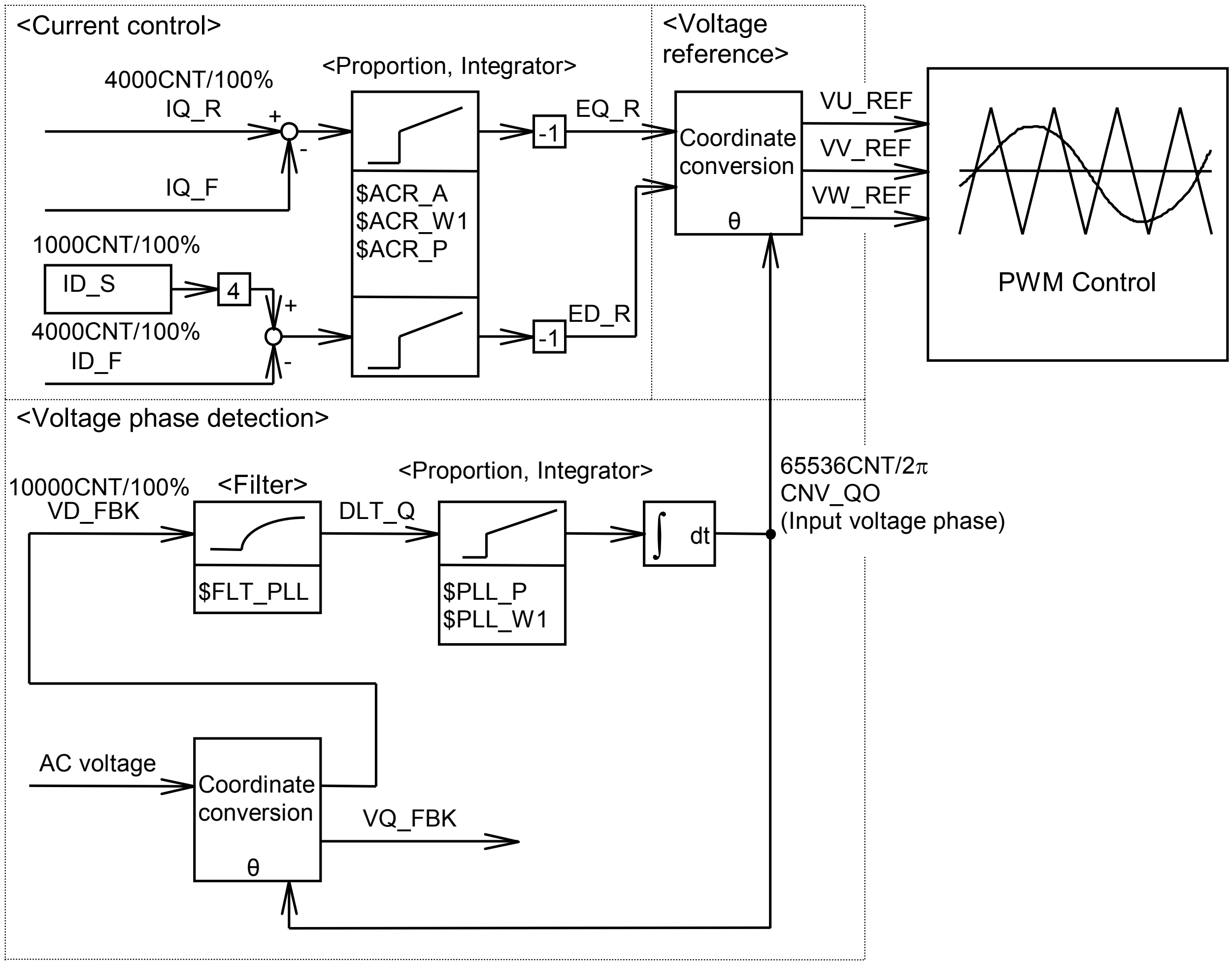


Fig. 5.6.3 Current Control, Voltage Phase Detection, PWM Control

5.6.4 Voltage Reference

(1) Voltage reference
EQ_R and ED_R, the results of current control, are input. Then, the information of power supply phase is input and a three-phase voltage reference is obtained. Since a timing interval is provided between the ON and OFF of the IGBTs, dead time compensation is inserted here. In addition, compensation is also applied here when the output voltage of a specific phase saturates and the voltage reference for PWM control is output.

(2) PWM control
The PWM control section outputs gate pulse signals based on the voltage reference of each phase.

(3) Gate board
The gate board insulates gate signals generated by the PWM section and amplifies them to drive the IGBTs.

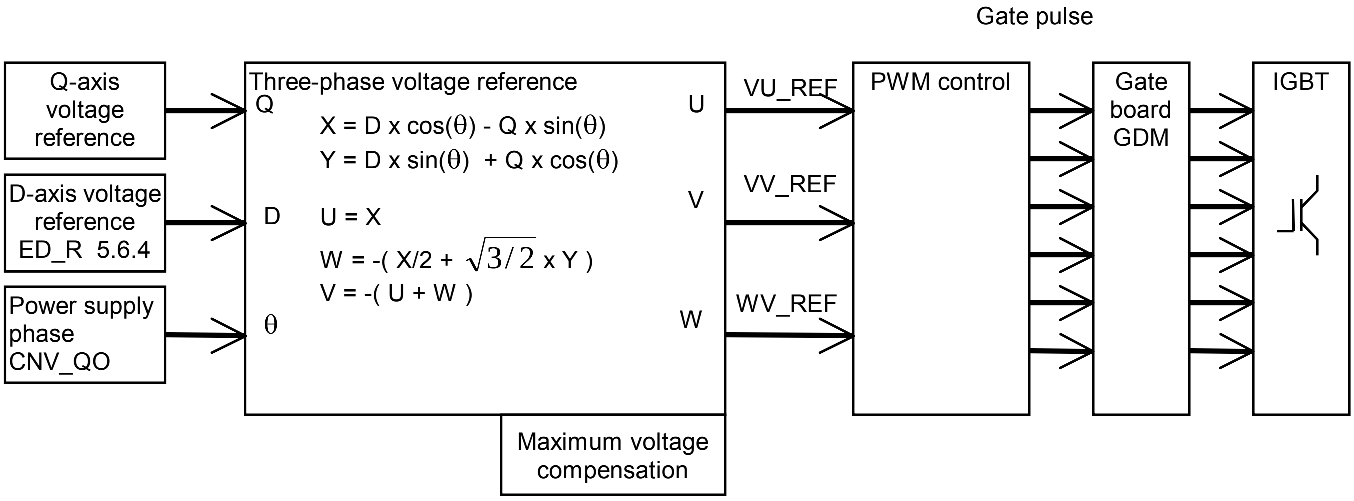


Fig. 5.6.4 Voltage Control

5.6.5 Voltage Saturation Restraint Control (VSC)

If the AD voltage/DC voltage ratio becomes excessively large, the current control output of the converter saturates, which may result in unsteady control. This can be prevented by voltage saturation restraint control (VSC). The basic operation is to generate D-axis current reference according to the primary voltage reference value.

Fig. 5.6.5 shows a control block diagram for the voltage saturation restraint control.

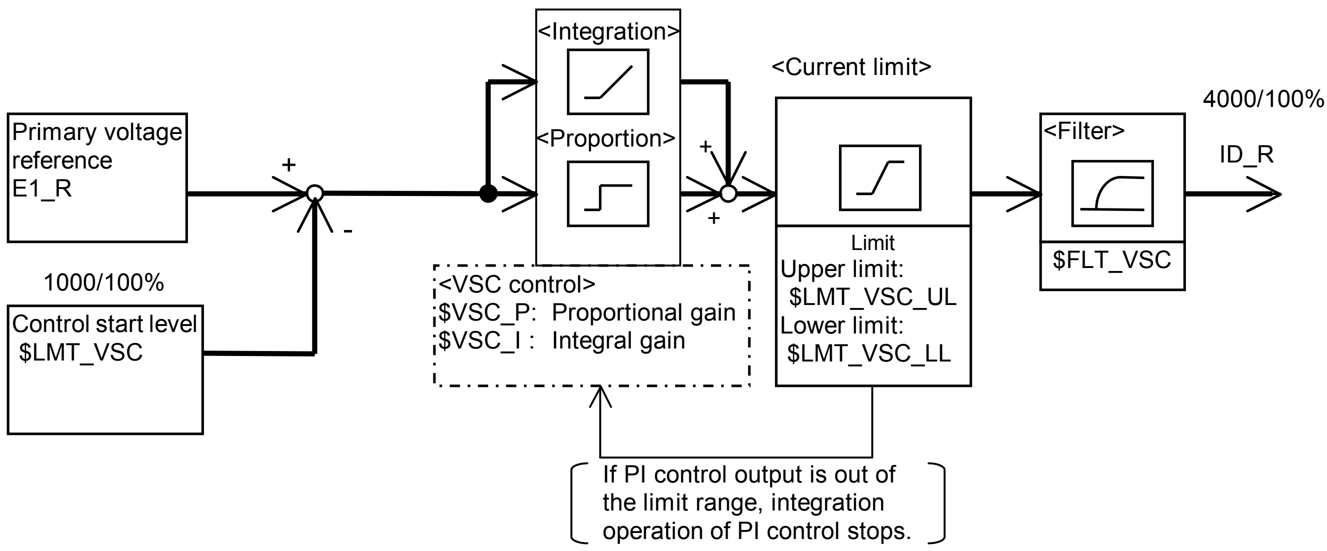


Fig. 5.6.5 Voltage Saturation Restraint Control

5.6.6 Reactive Current Voltage Control (RCV) (Optional)

Using the power regeneration function, reactive current voltage control (RCV) can be performed for the purpose of improving the power factor of the AC power supply. The AD voltage command value as a reference is input in RCV_REF_T through transmission and D-axis current reference ID_R is output so that the deviation from the AC voltage feedback VAC_F at that time will become 0.

Fig. 5.6.6 shows a control block diagram for reactive current voltage control. Since this control outputs ID_R in the same way as the voltage saturation restraint control in 5.6.5, if voltage saturation restraint control is active, the output of the voltage saturation restraint control takes precedence to prevent the interference of both controls.

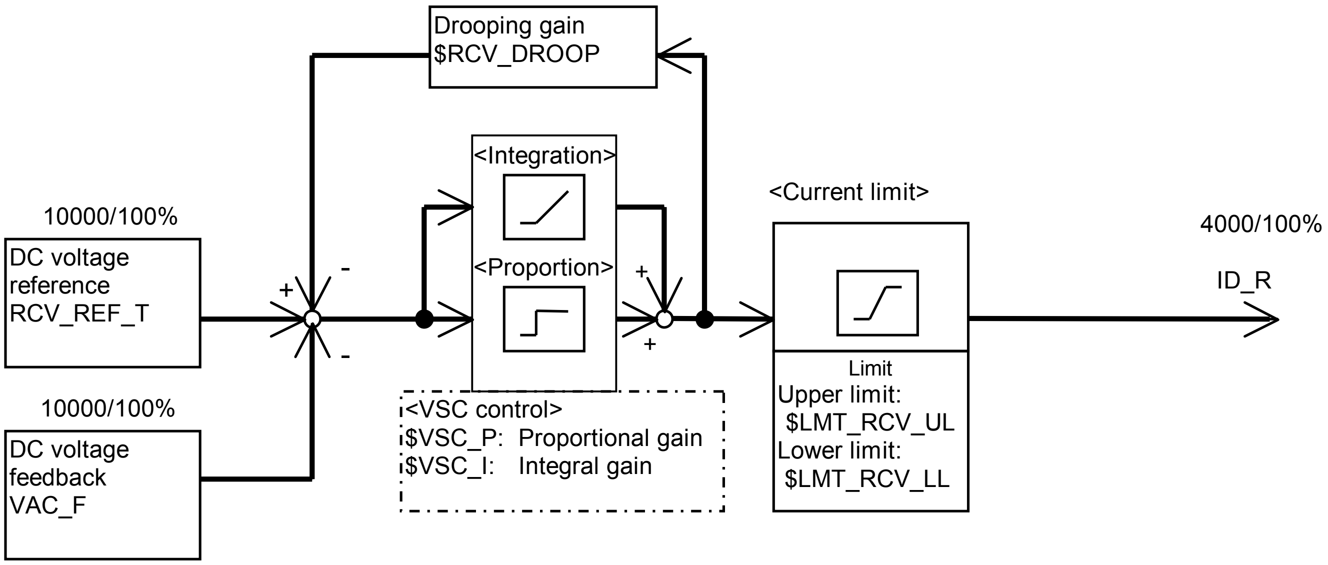


Fig. 5.6.6 Reactive Current Voltage Control

6 Maintenance (Common to TMdrive-30 and TMdrive-P30)

Preparations for inspection and maintenance

Stop the equipment → Turn off the main circuit power supply → Turn off the control power supply → Check the main circuit power supply discharge → Electrical check

See Chapter 1 for details.

The following points should be noted to use this equipment under the optimal conditions for a maximum period of time.

(1) Install it correctly.

(2) Follow the correct operation procedure.

(3) Carry out appropriate daily and regular inspections based on a maintenance/inspection plan.

In particular, maintenance and inspection is an effective means to prevent accidental faults of the equipment. Creating inspection check sheets and recording the equipment-specific characteristic changes and stability of the components and storing those records helps you perform maintenance and inspection effectively by preventing faults and investigate the causes of those faults. Maintenance and inspection comprises daily inspections and regular inspections. Inspections should be carried out in short cycles and more detailed in the beginning after the installation to prevent initial faults, while inspections after a certain period of time should be focused on checking of characteristic deterioration of parts.

6.1 Daily Inspections

Daily inspections mainly consist of visual inspections on the following items. Any abnormalities discovered should immediately be repaired.

(1) Installation environment check.
Temperature, humidity, presence of special gases, presence of dust.

(2) Abnormal sound or vibration of reactor, transformer, cooling fan, etc.

(3) Odor, smell of insulating substances, smell peculiar to each circuit device.

6.2 Regular Inspections

Carry out regular inspections centered on the following points.

(1) Cleaning of cubicle interior

(2) Cleaning of air filter

(3) Circuit part discoloration, deformation, leakage (capacitor, resistor, reactor, transformer, etc.) check

(4) Board (resistor, capacitor discoloration, deformation, board discoloration, deformation, dirt, soldered part deterioration, etc.) check and cleaning

(5) Wiring (discoloration due to heat, corrosion) check

(6) Tightened parts (looseness in bolts, nuts, screws) check

Before starting inspections of the main circuit of the equipment, be sure to carry out an electrical check approximately 5 minutes after the DC input power supply is turned off. Note that even after the input power supply is turned off the capacitors in the equipment still retain some charge, which may cause electric shock.

In order to prevent electric shock, be sure not to open the door while the equipment is operating. Never remove the protective cover of the main circuit.

6.3 Points of Maintenance

6.3.1 Cleaning of Main Circuit and Control Circuit

The first thing to do in maintenance and inspection is cleaning. Cleaning (once a month to once a year) should be carried out according to the conditions of the equipment. Before starting cleaning, turn off the power supply and check that the main circuit voltage is reduced to 0. Use a suction or blowing means to remove dust in the equipment. Note that an excessive pressure of compressed air may damage parts and wiring. Substances stuck to the circuits which cannot be dropped off by blowing should be wiped away using a cloth.

As a basic rule, cleaning should start from the upper part and end at the lower part. Dirt or metal fractions may fall from the upper part and checking the lower part first will prevent you from discovering or removing substances which drop from the upper part.

6.3.2 Enclosure and Structural Parts

(1) Cooling fan (any time)
Check if there is any abnormality with air flow, increased fan noise, etc. Particularly make sure you have replaced and tightened the bolts again which you removed once. Untightened screws may damage the bearing and blade, etc. due to vibration.

(2) Air filter (once a month to once a year)
Visually check if the air filter is clogged. Slightly hit it outside the room to drop off dust, remove dirt in an aqueous solution with neutral detergent, wash it with water and dry it.

(3) Main circuit parts and entire enclosure (once a month to once a year)
Check if dust is stuck to the enclosure interior or if there is any discoloration, heat generation, abnormal sound, odor or damage with the reactor, tightened parts of the conductor, fuses, capacitors and resistors. Check if some wire or mounted parts are almost broken, disconnected, loose or damaged.

6.3.3 Printed Circuit Boards

The boards which are made up of ICs and electronic components must be protected from dust, corrosive gases and temperature. Pay attention to the installation environment of the equipment. Regularly inspecting, cleaning and maintaining it in an optimal environment is essential to the suppression of faults of the equipment.

Since most of the components and parts are small and vulnerable to external forces, when cleaning them, use a brush, etc. to wipe off dust.

(1) Cautions on handling

- All maintenance work on the board should be carried out about 5 minutes after all power supplies are turned off.
- When removing the board, disconnect all the connectors and wires and remove the fixing screws on the upper part of the board. At this time, be careful not to drop the boards or fixing screws.
- When attaching the board, do so in the order opposite to the removing procedure.
  At this time, connect all the connectors and wires correctly.
  Note that since the control board contains capacitors, some parts continue to be live even after the power is turned off. When storing it, place it with the aluminum frame facing down and be careful not to cause short-circuits.
- The spare boards were shipped placed in a bag after antistatic measures were taken. Use this bag to store it. Note that the antistatic measures are provided only for the bag inner side.

6.4 Parts to be Regularly Renewed

To use the TOSVERT-250Wi under optimal conditions for a maximum period of time, it is necessary to regularly renew (repair) components whose characteristics have deteriorated. Table 6.4.1 below shows the parts used for the inverter equipment whose regular renewal is recommended and their recommended renewal period.

Table 6.4.1 Parts to be Regularly Renewed

Product name		Recommended renewal period	Remarks
Ventilation Fan	Large	3 years	
Air filter		6 months	Can also be cleaned.
Aluminum electrolytic capacitor	Main circuit	7 years	
	Board interior	7 years	
Control power supply equipment		7 years	
Fuse	Main circuit	7 years	
	Control circuit	7 years	
	Board interior	7 years	Gate board

- For replacement of the aluminum electrolytic capacitor in the board, contact Toshiba to secure the quality of the board. A fee is charged for the replacement. Additionally, since the gate drive board (ARND-2711) does not use any aluminum electrolytic capacitors, the capacitor replacement work is not required.

6.5 Recommended Spare Parts

Spare parts are important for quick recovery of important facilities from faults.

When parts in the equipment have broken down, spare parts are required to shorten the mean time to repair (MTTR). Since replacement of individual parts takes much time, it is recommended to replace by equipment.

Recommended spare parts for TMdrive-30 are shown in Table 6.5.1, and spare parts for TMdrive-P30 are shown in Table 6.5.2 and Table 6.5.3.

The recommended spare rate and minimum amount can serve as the references for the minimum number of spare parts relative to the total number of parts used. It is recommended to decide the amount according to the number of parts used.

For the inverter stack, the following measures are taken to prevent trouble when spare parts are replaced. The same applied to the multi-stage equipment.

- Replace the failing inverter stack with a spare inverter stack (by equipment) and restart the operation (to minimize MTTR).
- Then, replace the failing parts of the failing inverter stack with spare parts.

When an IGBT has broken down, its replacement requires a work environment which will prevent electrostatic destruction. Please contact our factory to request for repair service.

Table 6.5.1 Spare Parts for TMdrive-30

Product name	Type	Model & Rating	Qty. used for each capacity				Recom. level A:10% B:5% C:0%	Total quantity used	Standard recom-mended quantity
			1500	2000	2x1500	2x2000			
			1	1	1	1			
IS-BUS PWB	ARND-8204A	IS-BUS	1	1	1	1	A	4	1
Display Unit	DISP-3121A	DISP	1	1	1	1	A	4	1
I/O Terminal PWB	ARND-3120B	XIO	1	1	1	1	A	4	1
Main Control PWB	ARND-3110D	CTR	1	1	1	1	A	4	1
Interface PWB	ARND-3138A	MIF	1	1	1	1	A	4	1
Gate PWB	ARND-2711B	GDM	3	3	6	6	A	18	1
Fuse for Gate PWB	TSC	250V-1.6A	3	3	6	6	A	18	1
Cap-Unit	2Y3A1569G001	425VDC-5000uF-3S/4Px2	3	3	6	6	C	18	0
Capacitor	FXR425V5021UCES 5000UF	425VDC-5000uF	72	72	144	144	C	432	0
Resistor	CDR20L123JC	20W-12Ohm	72	72	144	144	C	432	0
Fuse	12.5URD73TTF350	1250V-350A	6	6	12	12	A	36	3
Micro SW for Fuse	MS7V1-5BSM		6	6	12	12	C	36	0
IGBT Power Unit	2Y3A1560G001		3	3	6	6	A	18	1
IGBT element	MG400V1US51A	1700V-400A	48	48	96	96	C	288	0
IGBT element	MG400V1US51	1700V-400A	48	48	96	96	C	288	0
Diode	50VH2G41	1700V-50A	84	84	168	168	C	504	0
Diode	800VHZ41	1700V-800A	24	24	48	48	C	144	0
Zener Diode	2Z33 33V-1.5W	1.5W-33V	48	48	96	96	C	288	0
Capacitor	EM1621R2D0UN2HS 1.2UF	1600VDC-2.0uF	36	36	72	72	C	216	0
Capacitor	EM162020D1UN2HZ 2.0UF	1600VDC-2.0uF	24	24	48	48	C	144	0
Capacitor	EM162020D1UN3HZ 2.0UF	1600VDC-0.22uF	24	24	48	48	C	144	0
Capacitor	EM162R22D0UN1HG 0.22UF	1600VDC-0.47uF	48	48	96	96	C	288	0
Capacitor	EM162R47D0UN2HW 0.47UF	1600VDC-1.2uF	24	24	48	48	C	144	0
Capacitor	DE1307E472Z3K	3.15kVDC-4700pF	132	132	264	264	C	792	0
Resistor	15500-0040	120W-10Ohm	24	24	48	48	C	144	0
Resistor	15497-2080	120W-10Ohm	12	12	24	24	C	72	0
Resistor	RM2 10-0HM-G	2W-10Ohm	96	96	192	192	C	576	0
Resistor	GS10A-560K-OHM-J(10W)	10W-560kOhm	24	24	48	48	C	144	0
Fuse	12.5URD273TTF1250	1250V-1250A	6	6	12	12	A	36	3
Micro SW for Fuse	MS7V1-5BSM		6	6	12	12	C	36	0
Thermostat	US-602AYTFL		3	3	6	6	C	18	0
Ferrite Core	F6045G		6	6	12	12	C	36	0
Ferrite Core	ESD-R-38B		12	12	24	24	C	72	0
Resistor	EF-2W 10K-0HM-J	2W-10kOhm	24	24	48	48	C	144	0
Lamp	AP6QS54-R	24VDC-13mA(RED)	2	2	4	4	B	12	1
Resistor	RS5FS51K-OHM-J	5W-51kOhm	6	6	12	12	C	36	0
Hall effective CT	NNC-40EMBT 4000A-10V	4000A/10V		2		4	C	6	0
Hall effective CT	NNC-30EMBT 3000A-10V	3000A/10V	2		4		C	6	0
Resistor	RS40H 20W-10K-OHM	20W-10kOhm	1	1	2	2	C	6	0
Fan	VAS405MD-43F	AC230V, 50/60Hz	2	2	4	4	A	12	1
MCCB	GV2-ME20*13-18A		1	1	1	1	C	4	0
Attachment for MCCB	GV2-AF02		1	1	1	1	C	4	0
Power Supply Unit	LWT50H-5FF	P5-8A,P15-1.5A,N15-1A	1	1	1	1	B	4	1
Power Supply Unit	RWS30A-24	P24-1.3A	1	1	1	1	B	4	1
Control Fuse (Option)	ATQ5	500VAC-5A	1	1	1	1	A	4	1
Holder for Fuse (Option)	USM1	600VAC-30A	1	1	1	1	C	4	0
Receptacle (Option)	CM-21	125VAC-15A	1	1	1	1	C	4	0
Transformer	PB5-200VA 200/220V,38V		1	1	1	1	C	4	0
MCCB for Fan	GV2-ME06*1-1.6A-3P		2	2	4	4	C	12	0
Auxiliary contact for MCCB	GV-AD1010*1A+1A		2	2	4	4	C	12	0
Relay	HH54PW-FL DC24V	24VDC-4ab	4	4	5	5	B	28	1
Socket for Relay	TP514X1		4	4	5	5	C	28	0
Air Filter	HB-20		9	9	18	18	B	54	2
Cable	CTR.CN1-DISP.CN1		1	1	1	1	B	4	1
Cable	CTR.CN3-DISP.CN3		1	1	1	1	B	4	1
Cable	CTR.CN14-XIO.CN1		1	1	1	1	B	4	1
Cable	MIF/CN13U-U.GDM/CN11		1	1	1	1	B	4	1
Cable	MIF/CN13V-V.GDM/CN11		1	1	1	1	B	4	1
Cable	MIF/CN13W-W.GDM/CN11		1	1	1	1	B	4	1
Cable	MIF/CN14U-U.GDM(S)/CN11				1	1	B	2	1
Cable	MIF/CN14V-V.GDM(S)/CN11				1	1	B	2	1
Cable	MIF/CN14W-W.GDM(S)/CN11				1	1	B	2	1

Table 6.5.2 Spare Parts for TMdrive-P30 (List 1)

Product name	Type	Model & Rating	Qty. used for each capacity		Recom. level A:10% B:5% C:0%	Total quantity used	Standard recom-mended quantity
			1700	2x1700			
			1	1			
IS-BUS PWB	ARND-8204A	IS-BUS	1	1	A	2	1
Display Unit	DISP-3121A	DISP	1	1	A	2	1
I/O Terminal PWB	ARND-3120B	XIO	1	1	A	2	1
Main Control PWB	ARND-3110D	CTR	1	1	A	2	1
Interface PWB	ARND-3138A	MIF	1	1	A	2	1
Gate PWB	ARND-2711B	GDM	3	6	A	9	1
Fuse for Gate PWB	TSC	250V-1.6A	3	6	A	9	1
Cap-Unit	2Y3A1569G001	425VDC-5000uF-3S/4Px2	3	6	C	9	0
Capacitor	FXR425V5021UCES 5000UF	425VDC-5000uF	72	144	C	216	0
Resistor	CDR20L123JC	20W-12Ohm	72	144	C	216	0
IGBT Power Unit	2Y3A1560G001		3	6	A	9	1
IGBT element	MG400V1US51A	1700V-400A	48	96	C	144	0
IGBT element	MG400V1US51	1700V-400A	48	96	C	144	0
Diode	50VH2G41	1700V-50A	84	168	C	252	0
Diode	800VHZ41	1700V-800A	24	48	C	72	0
Zener Diode	2Z33 33V-1.5W	1.5W-33V	48	96	C	144	0
Capacitor	EM1621R2D0UN2HS 1.2UF	1600VDC-2.0uF	36	72	C	108	0
Capacitor	EM162020D1UN2HZ 2.0UF	1600VDC-2.0uF	24	48	C	72	0
Capacitor	EM162020D1UN3HZ 2.0UF	1600VDC-0.22uF	24	48	C	72	0
Capacitor	EM162R22D0UN1HG 0.22UF	1600VDC-0.47uF	48	96	C	144	0
Capacitor	EM162R47D0UN2HW 0.47UF	1600VDC-1.2uF	24	48	C	72	0
Capacitor	DE1307E472Z3K	3.15kVDC-4700pF	132	264	C	396	0
Resistor	15500-0040	120W-10Ohm	24	48	C	72	0
Resistor	15497-2080	120W-10Ohm	12	24	C	36	0
Resistor	RM2 10-0HM-G	2W-10Ohm	96	192	C	288	0
Resistor	GS10A-560K-OHM-J(10W)	10W-560kOhm	24	48	C	72	0
Fuse	12.5URD273TTF1250	1250V-1250A	6	12	A	18	3
Micro SW for Fuse	MS7V1-5BSM		6	12	C	18	0
Thermostat	US-602AYTFL		3	6	C	9	0
Ferrite Core	F6045G		6	12	C	18	0
Ferrite Core	ESD-R-38B		12	24	C	36	0
Resistor	EF-2W 10K-0HM-J	2W-10kOhm	24	48	C	72	0
Lamp	AP6QS54-R	24VDC-13mA(RED)	2	4	B	6	1
Resistor	RS5FS51K-OHM-J	5W-51kOhm	6	12	C	18	0
Hall effective CT	NNC-40EMBT 4000A-10V	4000A/10V	2	4	C	6	0
Fuse	12.5URD2*73TTF1600	1250V-1600A	3	6	A	9	1
Micro SW for Fuse	MS7V1-5BSM		3	6	C	9	0
Resistor	RS40H 20W-10K-OHM	20W-10kOhm		1	C	6	0
Fan	VAS405MD-43F	AC230V, 50/60Hz	2	4	A	1	1
MCCB	GV2-ME20*13-18A		1	1	C	2	0
Attachment for MCCB	GV2-AF02		1	1	C	2	0
Power Supply Unit	LWT50H-5FF	P5-8A,P15-1.5A,N15-1A	1	1	B	2	1
Power Supply Unit	RWS30A-24	P24-1.3A	1	1	B	2	1
Control Fuse (Option)	ATQ5	500VAC-5A	1	1	A	2	1
Holder for Fuse (Option)	USM1	600VAC-30A	1	1	C	2	0
Receptacle (Option)	CM-21	125VAC-15A	1	1	C	2	0
Transformer	PB5-200VA 200/220V,38V		1	1	C	2	0
MCCB for Fan	GV2-ME06*1-1.6A-3P		2	4	C	6	0
Auxiliary contact for MCCB	GV-AD1010*1A+1A		2	4	C	6	0
Relay	HH54PW-FL DC24V	24VDC-4ab	3	3	B	6	1
Relay	HH54PW-FL DC100/110V	100/110VDC	3	3	B	6	1
Socket for Relay	TP514X1		6	6	C	12	0

Table 6.5.3 Spare Parts for TMdrive-P30 (List 2)

Product name	Type	Model & Rating	Qty. used for each capacity		Recommended level A:10% B:5% C:0%	Total quantity used	Standard recom-mended quantity
			1700	2x1700			
			1	1			
Relay	MM2XPN DC24V	24VDC	2	2	B	4	1
Socket for Relay	8PFA 250V-10A		2	2	C	4	0
Diode	1S1835	600V-1A	2	2	C	4	0
Switch	AP6QS54M-R	24VDC 13mA (Red)	1	1	C	2	0
Switch	AP6QS54M-G	24VDC 13mA (Green)	1	1	C	2	0
Switch	ASLN22211DN-R	24VDC 18mA (Red)	1	1	C	2	0
Switch	ASTN5122		1	1	C	2	0
Hall effective CT	NNC-20CA-30A/4V	IN:30AT/OUT:4V	1	1	C	2	0
Resistor	MLS30F400KNX900HZZ	300W-40Ω (2S-3P)	6	6	C	12	0
Resistor	RS60H 75K-OHM-60W	60W-75kΩ	1	1	C	2	0
Fuse	CC12BODKCV3SRF70Q20M	1200V-20A	1	1	A	2	1
Micro SW for Fuse	MC3E2-5BSM		1	1	C	2	0
Fuse	CC1051 CPGRB 20.127 20	1500VAC/1000VDC-20A	2	2	A	4	1
Holder for Fuse	PS1 20.127PRE+MC-PS		2	2	C	4	0
Resistor	MRC22N200KIA950CZZ	220W-20Ω (1S-4P)	8	8	C	16	0
Diode	15MA300	3000V-25A	8	8	C	16	0
MCCB	GV2-ME20*13-18A		1	1	C	2	0
Contactor	SC-0 AC220V 1A	550VAC-20A	1	1	C	2	0
Surge killer for Contactor	SC-N4 AC220V 2A2B	AC100V-250V(0.22UF+470Ω)	1	1	C	2	0
Trans	HS 8KVA-200/1600-1300V	P:200V-8kVA,S:1300/1450/1600V	2	2	C	4	0
Voltage Detection PWB	ARND-8122A	PDM	1	1	A	2	1
Ground Detection PWB	ARND-8216D	GDI	1	1	A	2	1
Air Filter	HB-20		9	18	B	27	1
Cable	CTR.CN1-DISP.CN1		1	1	B	2	1
Cable	CTR.CN3-DISP.CN3		1	1	B	2	1
Cable	CTR.CN14-XIO.CN1		1	1	B	2	1
Cable	MIF/CN13U-U.GDM/CN11		1	1	B	2	1
Cable	MIF/CN13V-V.GDM/CN11		1	1	B	2	1
Cable	MIF/CN13W-W.GDM/CN11		1	1	B	2	1
Cable	MIF/CN14U-U.GDM(S)/CN11			1	B	1	1
Cable	MIF/CN14V-V.GDM(S)/CN11			1	B	1	1
Cable	MIF/CN14W-W.GDM(S)/CN11			1	B	1	1

6.6 Prohibition of Modifications

Modifying this equipment is dangerous.
When you need modifications, contact Toshiba.

6.7 Movement

Inspections may be required before moving the equipment which has been installed.
Contact Toshiba.

6.8 Disposal

When part or the entire equipment is disposed of, you need special handling for waste disposal.
Consult with waste disposal professionals.

7 Data Control (Common to TMdrive-30 and TMdrive-P30)

7.1 Setting Data

We recommend you to save the inverter setting data as a personal computer data file.
It is recommended to control the setting data backed up in a file stored on the personal computer.

(1) File control

The setting data of the equipment is stored in the EEPROM as shown in Fig. 1.6.1. The EEPROM is a non-volatile memory which is not erased by turning on/off of the power supply. But it may be erased by some board fault, and so store it separately in a file on the personal computer. When the board is replaced, the file should be loaded.

The setting data is treated as an ACCESS file whose extension is MDB. An example of data naming is shown below Fig. 7.1.1.

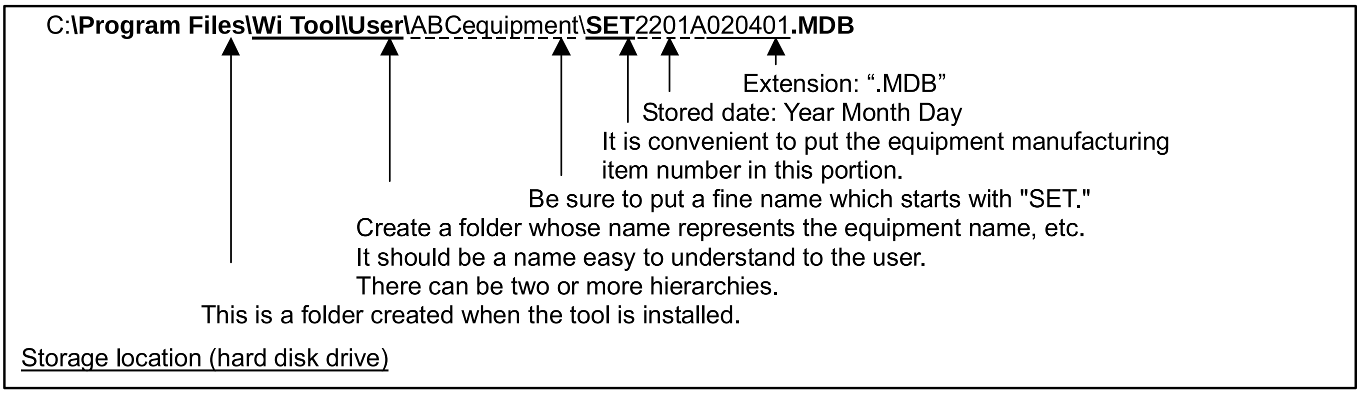


Fig. 7.1.1 Setting Data Filename

For the trace back data, replace "SET" by "TLB" so that it reads "**TRB**2201A020401**.MDB**".

8 Fault and Recovery (Common to TMdrive-30 and TMdrive-P30)

8.1 Cautions when Handling Fault

When a fault occurs, you are likely to repeat trial and error, pressed by the feeling that you have to recover it immediately. However, it is important to go back to the fundamentals and correctly understand the phenomena of the fault.

To do this, it is necessary to record the phenomena and conditions of the fault in detail from the electrical and mechanical standpoints, including the situation of the operator's operation. Collect as much data as possible on the following items to describe the operation situation when the fault occurred. See also chapter 1.

(1) **Operation panel display**
Record the fault message (sequential fault display) shown on the operation panel display at the moment the fault occurred.

(2) **Collection of trace back data**
Record the trace back data.

(3) **Operation different from ordinary operation**
Check if there was anything that affected the input power supply of the equipment at the moment the fault occurred (for example, powering-on of large-capacity equipment which is connected to the common AC power supply or short-circuits, etc.) and record it.

(4) **Power failure**
Check if the input power supply of the equipment was disconnected at the time of the fault (for example, if the line of the AC power supply was switched or if the breaker was turned on or off) and record it.

(5) **Load condition**
Check if the power supply of the load (motor) connected to the equipment was turned on/off or the load was drastically changed at the time of the fault and record it.

(6) **Operation**
Check what kind of operation the operator did in the central operator's room at the time of the fault and record it.

(7) **Installation environment**
Check if there was any abnormal ambient temperature rise at the time of the fault or before and record it. (Fault of air-conditioner or ventilation system)

(8) **Changes**
Check if there were any recent changes to other apparatuses around the equipment (for example, if some electrical work was carried out on the apparatuses around the equipment) and record it.

(9) **Inspection situation**
Check if there was excessive dust or leak and record it.

(10) **Lightning**
Check if there was lightning in the neighborhood of the equipment and record it.

(11) **Abnormal sound, odor**
Check if there was any odor or abnormal sound around the equipment at the time of the fault and record it.

(12) **Control power supply**
Check if the control power supply of the equipment was functioning normally at the time of the fault and record it.

Understanding the situation in this way serves as a reference to determine whether the nonconformity is attributable to factors inside or outside the equipment. Further, this information becomes an important clue to find out the cause of non-reproducible nonconformities or faults and it is important to keep precise record.

8.2 Traceback

The drive unit features a traceback function that saves the status of the drive before and after fault occurrence. Traceback data is useful for failure cause analysis. The inverter (TMdrive-30) and converter (TMdrive-P30) can save traceback data for up to 7 fault occurrences, respectively.

Each traceback data consists of high-speed traceback 14 channels, standard traceback 28 channels, and long traceback 8 channels, and sequence trace.

Table 8.2.1 lists the characteristics of high-speed, standard, and long traceback data. Figure 8.2.1 shows the data collection time for each traceback data.

Table 8.2.1 Characteristics of Traceback Data

Type	Quantity of Sampling	Sampling cycle	No. of channels	Signals to be saved
High-speed traceback	256 items (30 items after fault occurrence)	Current control cycle (When the carrier frequency is 1536Hz, 325μs)	14ch	IU_F, IW_F, IQ_REF, ID_REF, IQ_FBK, ID_FBK, EQ_R, ED_R, E1_R, VU_REF, VV_REF, VW_REF, VU_REF_B, VV_REF_B
Standard traceback	256 items (30 items after fault occurrence)	1ms	28ch	Set by $TRB01_OP_AS ~ $TRB28_OP_AS
Long traceback	256 items (items for 500ms after fault occurrence)	Set by $TRB_TIME_LONG (standard: 10ms)	8ch	Set by $TRB_L1_OP_AS ~ $TRB_L8_OP_AS

Sequence traceback records the change of fault sequence for up to 400ms after the change of the first occurred fault sequence.

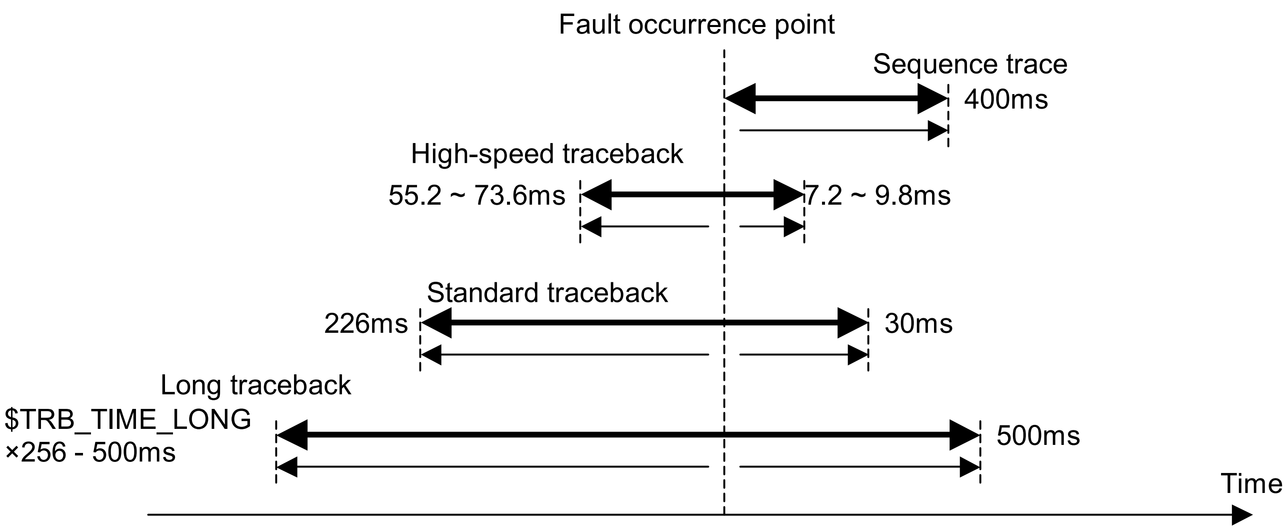


Fig. 8.2.1 Traceback Data Collection Time

The recorded traceback data can be displayed and saved using the maintenance tool.

By adjusting the timer of the drive unit from the maintenance tool immediately after the fault occurrence and before absorbing data, the fault occurrence time to be recorded as traceback data can be corrected to more accurate time.

8.3 How to Repair

8.3.1 Cautions on Repair

(1) Prepare necessary tools and drawings, etc. before starting the work.

(2) Be careful not to damage other parts when removing some parts.

(3) Do not make wrong connections when recovering from the fault and put markings, etc., if necessary.

(4) After recovery, check the wiring according to the schematic.

(5) Use right tools (torque wrench, etc.) when handling screws.

(6) Special cares are required when handling heavy articles.

(7) After the work has been completed, check the number of tools to make sure that no tools are left inside the cubicle.

8.3.2 Replacing Units

For details of unit replacement, see the Unit Replacement Manual (document No. 6F3A4795)

8.4 Restoring Setting Parameters

In this equipment, as the control power is turned on, the program starts running automatically. In the following case, the setting parameters need to be reloaded.

- The message, “PI-183” appears on the display. The setting data may be faulty.
- All of the setting data are changed completely. <Example> The circuit board is used in other equipment.
- The circuit board is replaced with a spare board.

8.4.1 Reloading (Personal Computer Tool)

The data can be loaded with the personal computer connected to this equipment. Using this personal computer tool, the setting data saved in the FDD or HDD can be loaded.

For details, see the manual for the tool.

(1) Turn on the control power.

(2) Connect the personal computer tool.

(3) Log on to Access level 9 (Full access).

(4) Using “Setting value control,” setting data on FDD or HDD can be reloaded to the equipment RAM.

(5) Transfer this data to the EEPROM in the equipment.

(6) Turn off the control power, and turn it on again. (Initialization)

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