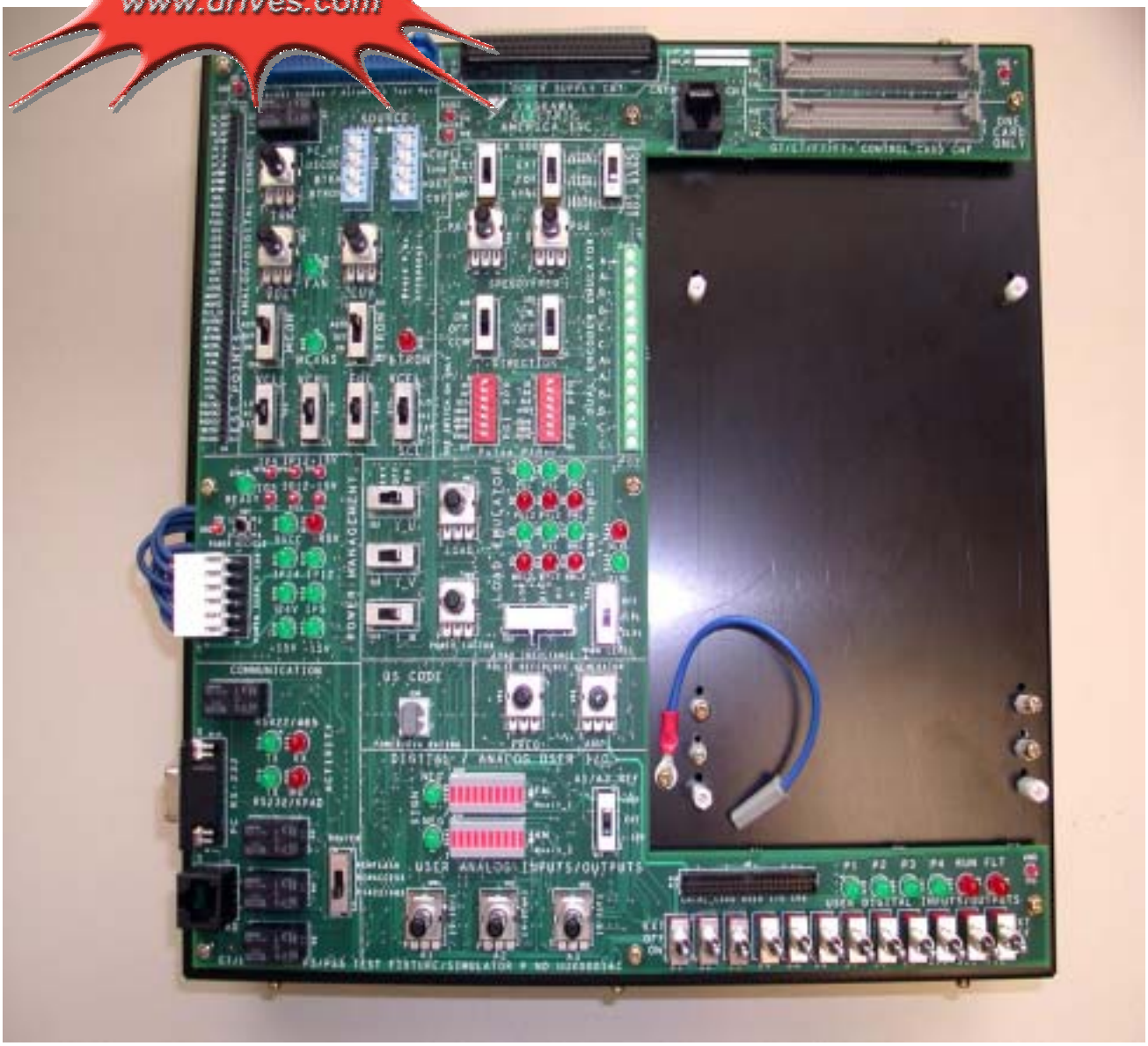
YASKAWA

G7/E7/F7/P7/G5/P5/PS5 Drive Simulator User Manual



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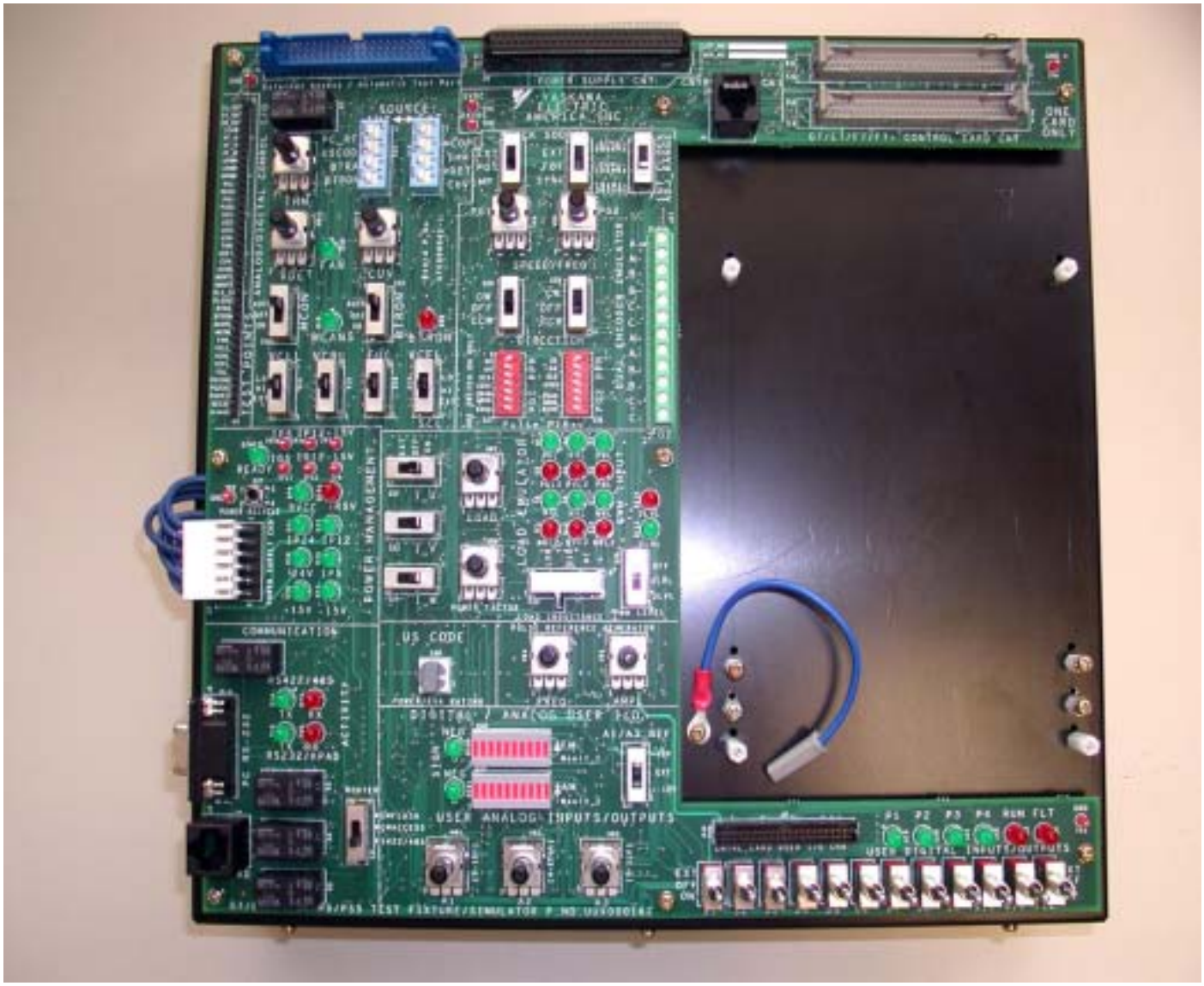

Figure 1: Simulator unit with no control card installed

1. Introduction:

This control board tester and variable-power-factor load emulator allows the user to test all the basic and advanced functions of above mentioned control cards without any need for actual drive power supply sections, motor stand, load stand and power stages.

All of the required signals to operate the cards are simulated through DC and AC voltages and currents, adjustable by potentiometers and switches. LED's for digital and VU meters for analog signals monitor all the control and user outputs. Yet all the signals are provided at test points for external access. PC serial 9-pin connector can be routed to card's RS232, RS485 or RS422 ports through on board converters. Two master-slave PG emulators are capable of emulating wide PPR range of encoders. A true three-phase on-board emulator can simulate induction motors with adjustable load and power factor for both 2 and 3 level drives. A current-limited pulse reference generator can provide adjustable amplitude and frequency independently. An automatic power recycling circuit reboots the control card safely, with feedback. Bipolar I/O references, active current source, external access port, supply voltage monitors, and capability of supporting a very wide range of control cards are also provided.

Please note that this equipment is intended for qualified engineering personnel only, familiar with Yaskawa Drives and technical principles of variable speed AC drives and/or software engineering.

2. Features and Applications:

- CASE development: As this unit provides all the digital and analog I/O available in the control cards with the monitoring and measurement capabilities, it will be ideal for any level of CASE design and verification.

- Firmware development: In addition to the general I/O, different emulators provide reference, feedback, load and power factor virtual signals for the firmware designer to test under the most realistic environment, even for different PWM index implementations.

- Drive application engineering: Versatile communication routers, loading emulators, reference and feedback encoders and generators capabilities, in addition to I/O handling and easy-access test points, will make it ideal for application verifications and testing.

- Wizard software and utilities development and testing: In addition to all the above, External Access/PLC port-EAP opens a gate to automatic repetitive tests, usually required for communication software verifications. The manual or externally controlled automatic power recycling is another unique feature to help out the software test and development engineers.

- Hardware Development: The realistic physical environment, access to all ports and signals, easy access test points, measurement and monitoring features, actual PWM signal outputs, dual encoder emulations and extensive test points and EAP, will all be the ultimate platform for hardware development.

- Cross Referencing of different drive generations: In order to compare drives performances for an application or even having all the above features for other old or new drives, their control cards can easily be tested on this unit through cable adaptors. Therefore it can replace most of the present or even future test units.

- Automatic Test Setup: Almost all the hardware and software platforms, options, extensions, communication protocols and controls, Wizard tools and Test tools can be either implemented for production or tested during their development phases.

Figure 2: Simulator with G7 control card installed and running under simulated load

3. Precautions:

- This unit is designed for office/lab environment and not for harsh industrial conditions. Also as an open-chassis electrical system, all the usual precautions for these devices are expected accordingly. Any conductive liquid spills, tool drops, wiring shortages, heavy physical blows or extensive electrostatic discharges can cause damage to it and/or its connected accessories. However due to the applied precautions in its design, these damages might be very limited and easily repairable while other modules keep on functioning properly.

- There is no level of electrical isolation in this unit and as soon as any control card gets connected to this unit, it loses its isolation barriers. This is for ease of operation, probing, lowering the costs, etc. This is done as to the application and purpose of the unit, which is not definitely industrial control. There are only two isolated/unregulated IP5/IG5 and IP12/IG12 voltage sources, accessible through test points on J1. Only mounting I/O terminal cards and providing external 24VDC/AC level commands, will revive this isolation.

- The external access port-EAP pins are all protected against static and dynamic HV/HC/HF interferences but still applying wrong signals or shorting might interfere with the unit logic and cause invalid reactions and/or readings. Please refer to this manual for the appropriate probing and signal applications for each pin.

- The power supply pins provided to the user at J1 test points and J8-EAP, are all current-limited to 80mA. Any loading more than 100mA, may cause damage to the protective current-limiting resistors and the unit.

- There are no high voltages above 24VDC present on this unit anywhere except the components and power supply module inside the grounded chassis, which carry the Mains voltage. Care should be taken to use the provided grounded AC-cord and outlets in order to have full ground protection of the unit.

- Control cards G7/E7/F7 and G5/PS5 have their own connector on the unit. Please refer to the labels next to each connector, before doing any wiring to the control cards (G7/E7/F7 to J9 and G5/PS5 to J10). Depending on their screw hole positions, you can use the provided spacers to mount them on the unit.

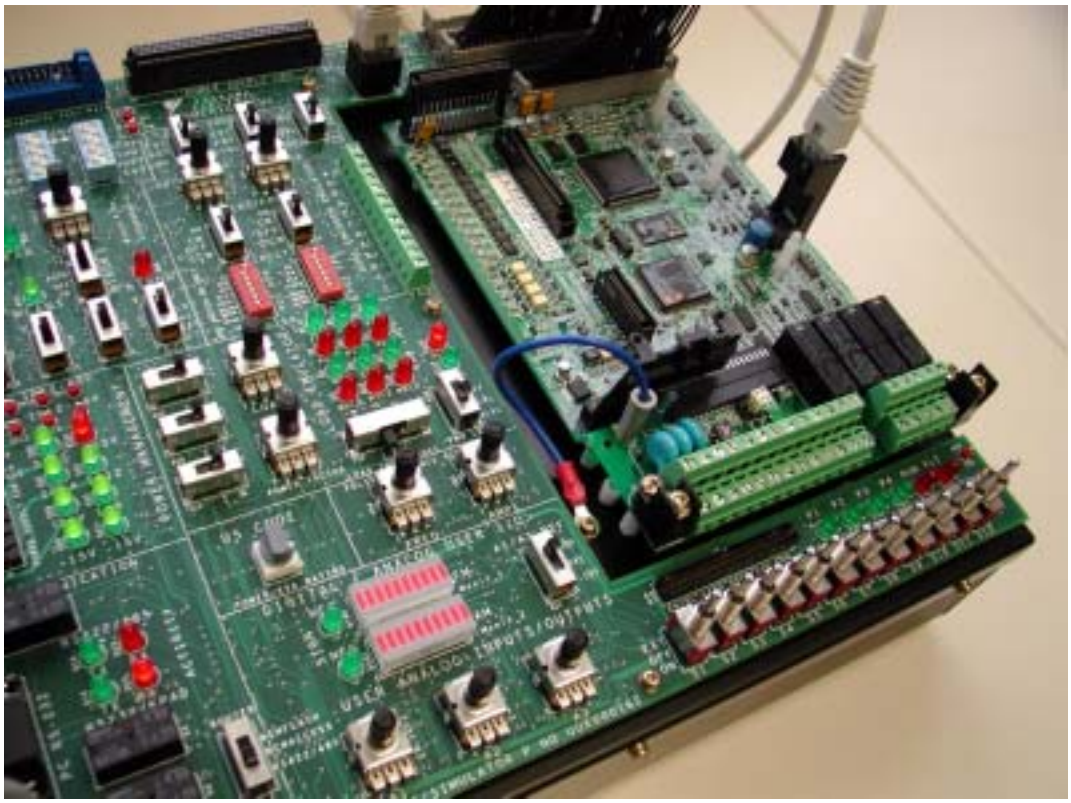

Figure 3: Simulator with E7 I/O card installed

4. Initial Switches and Potentiometers Settings:

- Default positions for switches and pots to minimize the faults on the connected control cards:

SWITCH	TOP	MIDDLE	BOTTOM
S1-S12		X	
S21	X		
S22-S24		X	
S19 & S20	X		
S14 & S16	Set Toward Internal Sources only.		
S13		X	
S15		X	
S17		X	
S18		X	
S38			X
S35		X	
S32	Set to Low Inductance position for most cases.		
S28			X
S26 & S30		X	
S25 & S29		X	
S27 & S31	First position only ON for 32PPR.		
S36	Set as to control card's Power ratings in O2-04*		
Potentiometer	Leftmost	Middle	Rightmost
VR1-VR3		X	
VR10	X		
VR12			X
VR11		X**	
VR6	X		
VR7		X	
VR8 and VR9		X	
VR4		X	
VR5	X		X

* Please note that when mounting a control card to the unit, in order to keep all the settings inside control card unchanged, you might need to try every single setting of S36 and recycle the power each time by S37 push button, to check which code matches with the control card's. This will take about 1 minute at the worst case.
** VR11 will cause OV or UV faults, when rotated toward left or right ends. Please adjust it around the middle until the faults go away automatically.

Figure 4: Simulator with G5/P5/PS5 control card installed

5. Module Description and Usage Guide:

- **User I/O terminal:**
    1. Digital inputs: middle-positioned toggle switches ON/EXT/OFF S1-S12.
    2. Digital outputs: Four green (D19-D22) and two red LED's (D23 and D24).
    3. Analog inputs: 0-10V/±10V or external for AIN1 and AIN3. 4-20mA for AIN2.
       VR1 is A1, VR2 is A2 and VR3 is A3. The reference voltage will be selected through S21 from 10V, ±10V and External.
    4. Analog outputs: Two 10-LED displays, U31, U33 with negative-sign LED's, D140 and D141 will monitor the AM and FM outputs in almost ±1V steps.

- **Pulse generator module:**
    1. Amplitude: adjustable through VR5 between 0-22V
    2. Current: Limited and short-circuit protected at 25mA dynamically
    3. Frequency: Adjustable through VR4 between approx. 15Hz-25kHz

- **Communication module:**
    1. RS-232, RS-485 and RS-422 standards and voltage levels are supported.
    2. RS-422/RS-485 flow control selectable between internal or RTS signal through S14-position1 switch (internal is RS422 and external is RS485 through RS232).
    3. Four LED's, D13-D16 monitor all the transmission and reception activities.
    4. Connectors: RJ-45 for Keypad, DB9 for RS-232 and Header for RS422/485 (J4 to connect to control-board's keypad connector, J5 for PC, J3 for keypad, J2 for user I/O-RS422/485)
    5. Routing: Through S38 (RS422/485: PC-RS232 will be routed/converted to RS422 of the drive and keypad will be routed to control card's keypad port, MEMACCESS: PC-RS232 will be routed to control card's keypad port and keypad will be disconnected, MEMFLASH: PC-RS232 will be routed to control card's keypad port in FLASH mode and keypad will be disconnected).
    6. In communication router switch (S38) mode of "RS-422/485", the connected PC through its RS-232 will be also able to participate as a RS-485 network participant. Therefore, flow control will be through its RTS pin and accessible through S14/1 switch, set to "External". Also the related parameter in the drive should be set accordingly (H5-07←1) for the network-side flow control.

       Note: The unit in this mode does not compromise the network/drive isolation, as the control card's link to network will be differential anyway.

- **Power supply module:**
    1. Voltages available:
       ±15VDC, 24VDC, 5VDC, IP5VDC (10V-unregulated),
       IP12VDC (19V-unregulated/unloaded), IP24VDC (26V-unregulated/unloaded)
    2. All supplies monitored by LED's D56-D59, D31-D33.
    3. Power Recycle: Manually (through push button S37 -Power Recycle) and externally (through EAP-External Access Port) recycled and monitored toward the control card, in almost 1 second. The ready signal will be also generated and available to EAP after 2 seconds for automatic testing purposes. LED's D148 (READY) and D151 (R5V) monitor the whole recycling process either way. Please note that this feature is exactly like recycling the main power switch of the unit with exactly same functionality and effect.
    4. Current available to external devices is limited at less than 50mA for all supplies. Please refer to the pin-array on the left side of the unit.

- **Dual Encoder emulator module:**
    1. PG-I is assumed to be the slave motor encoder and PG-II, the master motor encoder. However they are independently interchangeable based on application.
    2. Logic level: 5V-TTL differential
    3. Max frequency: Approx. 25Hz to 44kHz separately adjustable and range-selectable through VR8, VR9 and S28 (25Hz-44kHz, 250Hz-44kHz and 2.5kHz-44kHz).
    4. Signal format: 90°-Phase-shifted, quadrature, differential A/~A, B/~B, C/~C

5. Loading: 20mA max each channel
6. Direction of rotation is controlled by slide switches: S25 and S29 as CW/OFF/CCW.
7. Clock source: Selectable from internal generators, control card's pulse output (for PG-I only), external source or PG-I (for PG-II only) through S26 and S30.
8. The ratio between input clock to output encoder frequency is **2:1**.
9. Pulse per Revolution: Each encoder's PPR can be set by S27 and S31 to values of 32, 64, 512, 1024, 2048, 4096 and 8192 PPR. One switch position at all times should be on only otherwise the smallest ratio would become the PPR anyway.

- **Load Emulator module:**
  1. Load Inductance range: Adjustable through S32 for most carrier frequencies
  2. Inductance tuning: 0.1 to 0.99 for most carrier frequencies through VR6
  3. Carrier frequency support: 400Hz-15kHz from the control card
  4. Multi-level PWM: Two and three level topologies, and floating through S35.
  5. Load current signal: Fully adjustable between 0-200% through VR7
  6. IUVW (=IU+IV+IW) output for ground current measurements at J1 monitors. This signal is an exact emulation to the one generated inside the control card for threshold testing purposes
  7. PWM Monitoring: Twelve 2-level-phase-leg positioned LED's for both 2 or 3 level fire-pulse PWM signals, 2-levels are red and 1-levels are green, D1-D12.
  8. Output signal access: Selectable through S22, S23, S24 (Internal/OFF/External)
  9. PWM outputs loading: 0-10Vrms at 500 Ohms minimum load impedance

- **Control I/O and External Access Port (EAP):**
  1. All the control-side analog inputs are selectable between internal and external sources at EAP through S16.
  2. All the control-side digital I/O's are selectable between internal and external sources at EAP through S13 to S18.
  3. MCON and BTRA signals have Auto/Off/On modes through S19 and S20.
  4. VCLL, VCHL, VCFL/SCL, FUL signals have High/Low/External modes through S13, S15, S17 and S18.
  5. Digital outputs routed to EAP, are all open collector/24V/40mA-max.
  6. All the digital inputs are 5V-TTL except "MCOPL", being 24V/2mA.
  7. Analog inputs to the control card:
     -"THM": 0-5VDC (internally through VR10)
     -"VDET: -10VDC-0VDC (internally through VR11)
     -"CUV": 3.3VDC-5VDC (internally through VR12)

- **US_CODE module:**
  1. Selectable between internal HEX-rotary switch S36 and EAP through S14.
  2. Format: 5V-TTL inputs from EAP, low-active/negative-logic.

- **Test Points Connector J1:**
  1. Connector: Single-row header, .100" pitch, 40-pins
  2. Loading: All short-circuit protected, measurement impedance 10kOhm-min. See Note 1.
  3. Available Signals: All the signals at this connector are outputs except one, Pin 38, PGCKIN.

  All the signals in detail are described in the next page table 1.

Pin	Label	Type	Level	Description
1	IU_OUT	Analog	±15VDC	Emulated motor current signals from the three phases individually, amplitude-controlled and phase-controlled (power factor or inductive load) through VR6 and VR7.
2	IV_OUT			
3	IW_OUT			
4	IUVW			Emulated sum of the three phase currents inside the drive.
5	PF_U			Emulated motor current signals from the three phases individually, only phase-controlled (load power factor or the level of inductance) through VR6, without amplitude control.
6	PF_V			
7	PF_W			
8	UPWM	Digital	±15VDC	Emulated IGBT outputs from the drive to run a motor. Later these power signals will be fed to the power-factor and level control circuits for emulating the actual motor itself.
9	VPWM			
10	WPWM			
11	NUL		5V-TTL	Sine-weighted, multi-level PWM signals, generated by the control card-under-test. All four signals from one phase leg (U) are brought here. NU2L and PU2L are only available from two-level drives though, such as G7-400V class and will be off for regular one-level drives. See note 2 below.
12	NU2L			
13	PUL			
14	PU2L			
15	US1	Digital	5V-TTL	The power rating of the drive or US-CODE, provided to the, will be actually present at these pins. These signals are high-active or positive logic. These four signals constitute a half-byte or nibble code with US4 being the MSB and US1 the LSB. This code is a drive parameter content .
16	US2			
17	US3			
18	US4			
19	THM	Analog	±10VDC	Analog control signals from drive's power section to the control card. THM reports the heat sink temperature, VDET reports the DC Bus voltage and CUV monitors the power supply voltage to control card.
20	VDET			
21	CUV			
22	AIN2	Analog	±10VDC	Analog signals from the user I/O terminal, AIN2 is reference input 2 (4-20mADC, when disconnected from the drive, 1-5VDC, when connected). MONT1 and MONT2 are the two user analog outputs from the drive.
23	MONT1			
24	MONT2			
25	PLS_IN	Digital	24VDC	PLS_IN is the pulse reference input of the drive, fed by the unit pulse generator (0-24VDC/15Hz-25kHz). PLSOUT is drive's pulse output.
26	PLSOUT			
27	BTRA	Digital	5V-TTL	BTRA is the drive's command to turn on the Braking transistor, in case of rising DC Bus voltage and BTRON is the drive's response feedback for it.
28	BTRON			
29	MCOPL	Digital	24VDC	MCON is the drive's command to close the soft-start relay, when its capacitors are charged up and MCOPL is the drive's response feedback.
30	MCON			
31	FAN	Digital	5V-TTL	Drive's command to control the heat sink blowers during motor is running.
32	VCLL	Digital	5V-TTL	Low Active or negative logic signals to report drive's power section status. VCLL and VCHL report the power supply safe voltage levels in specific drives, VCFL (SCL in G5) reports power supply or braking transistor failure and FUL reports the main DC Bus fuse failure to the drive.
33	VCHL			
34	VCFL			
35	FUL			
36	PG1CKO	Digital	5V-TTL	TTL-Resolved independent sweep clocks to feed the PG1 and PG2 encoders from any selected source at double the encoder frequencies.
37	PG2CKO			
38	PGCKIN	Digital	5V-24V	External Clock source input to both encoder emulators, routed by S26/S30.
39	REC5V	Supply	5V-TTL	Main 5V supply to control card under test, recycled by S37 push button.
40	IP24VDC	Supply	24VDC	Unregulated 25VDC supply for external use, 50mA maximum load.

Table 1: The simulator signal descriptions available at the Test Points connector, J1

Note 1: Although all the test point signals are protected against shorts or overloads but can still distort the normal logical operations of the unit circuitries or even cause damage to them by improper connections or shorting.

Note 2: These 4 PWM signals from the control card, ***NUL, NU2L, PUL and PU2L*** should be probed very carefully otherwise they can cause damage to the control card and/or unit motor emulator circuitry, in case of interference.

- **External Access Port - EAP:**
    1. Connector: Standard dual-row header, .100" pitch, 40-pins, shrouded/protected
    2. Loading: All short-circuit protected, measurement impedance 10kOhm-min. See Note 3.
    3. Application: Automatic hardware/software test setups, PLC-driven controls, Load Emulation
    4. Available Signals: Both inputs and outputs, digital and analog signals are provided at this connector. Most outputs are open-collector/24V and most inputs are 5V-TTL compatible.

Pin	Name	I/O	Type	Level	Router	Logic	Description
1	US1	Input	Digital	TTL	S14/2	Low	The 4-Bit input code to assign the drive size, with US1 being the LSB and US4, the MSB.
2	US2						
3	US3						
4	US4						
5	IP24V	Output	Supply	HTL	N/A	High	Unregulated 24VDC/200mA (25VDC) supply.
6	RDY	Output	Digital	TTL	None	Low	Goes Low when recycled control card is ready again.
7	FUL	Input	Digital	TTL	S18	Low	Should go low to induce a main DC Bus fuse failure.
8	RST	Input	Digital	TTL	None	Low	Should go low to recycle/reset control card power.
9	I_STAR	Output	Analog	±15V	None	N/A	Displays sum of the emulated three phase currents.
10	FAN	Output	Digital	TTL	None	High	Goes high, should the blowers start working.
11	MCON	Output	Digital	HTL	None	Low	Goes low when DC Bus Caps voltage is normal.
12	NWL	Output	Digital	TTL	None	Low	Two PWM signals for lower half of one phase leg directly from control card. See Note 4.
13	NW2L						
14	BTRA	Input	Digital	TTL	S14/3	High	Should go high when braking transistor is on.
15	BTRON	Input	Digital	TTL	S14/4	Low	Should go low to turn the braking transistor on.
16	MCOPL	Input	Digital	HTL	S16/1	High	Should go high to report soft starter relay is closed.
17	THM	Input	Analog	0-5V	S16/2	N/A	Lower the voltage, higher the temperature.
18	VDET	Input	Analog	-7.5V	S16/3	N/A	0→-7.5V, more negative, higher DC bus voltage.
19	CUV	Input	Analog	3-5V	S16/4	N/A	Lower the voltage, less the control side voltage.
20	VCLL	Input	Digital	TTL	S13	Low	Should go low to report drive control low voltage.
21	VCHL	Input	Digital	TTL	S15	Low	Should go low to report drive control high voltage.
22	VCFL	Input	Digital	TTL	S17	Low	Should go low to report power supply failure (SCL).
23	I_U	Input	Analog	±15V	S22	N/A	They provide any arbitrary current waveform for the control card under test, in any combination with or without the internally emulated/controlled ones.
24	I_V				S23		
25	I_W				S24		
26	GND	REF	N/A	0V	N/A	N/A	GROUND reference for all the I/O signals available.
27	DI-1	Input	Digital	HTL (24V)	S1	High	Provides the access to the user digital inputs of the control card under test. DI-1 and DI-2 are reserved for Run commands in all drives. DI-1..DI-7 inputs are used in F7, E7 drives and DI-1..DI-8 for F7+ drives. All 12 inputs are available to G7 drives. Should go high to activate the inputs. To route each input to the external port pins, the associated switch should be set to EXT (external) position.
28	DI-2				S2		
29	DI-3				S3		
30	DI-4				S4		
31	DI-5				S5		
32	DI-6				S6		
33	DI-7				S7		
34	DI-8				S8		
35	DI-9				S9		
36	DI-10				S10		
37	DI-11				S11		
38	DI-12				S12		
39	AIN1	Input	Analog	±10V	S21	N/A	To feed the external reference value to the drive, VR1 and/or VR3 should be set to minimum (left) position.
40	AIN3						

Note 3: Although all the I/O pins in this port are protected against shorts or overloads but can still distort the normal logical operations of the unit and/or control card under test circuitries, causing damage to them by improper connections, high voltages, or shorting.

Note 4: These 2 PWM signals from the control card, ***NWL and NW2L*** should be probed/monitored very carefully otherwise they can cause damage to the control card and/or unit motor emulator circuitry, in case of interference.

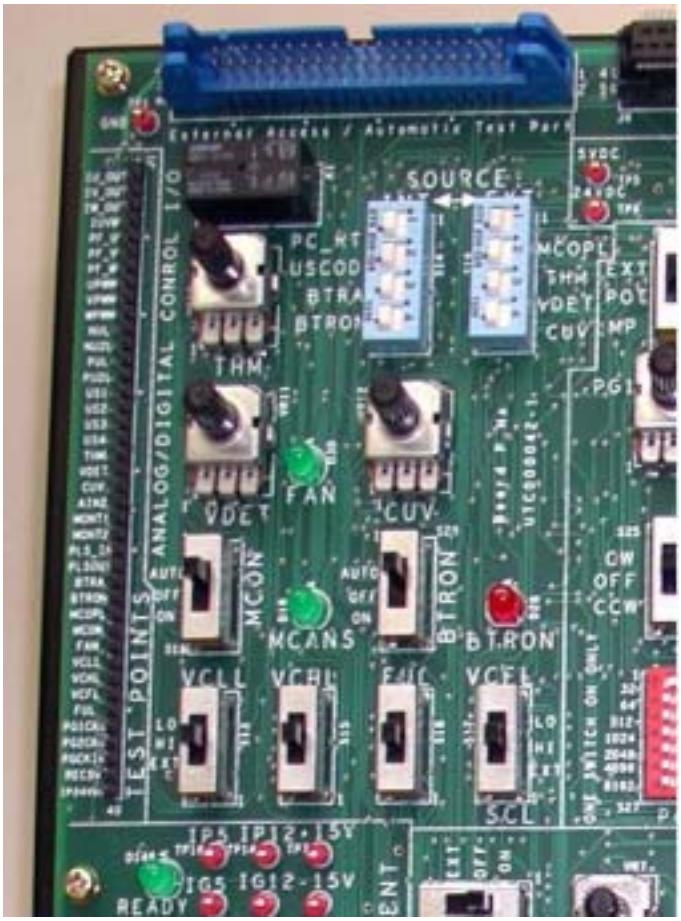

Figure 5: The test points and external access port (EAP) on the simulator

Figure 6: Power entry module with on/off switch and spare fuse inserts

G7/E7/F7/P7/G5/P5/PS5 Drive Simulator

YASKAWA ELECTRIC AMERICA, INC.
Drives Division
16555 W. Ryerson Rd., New Berlin, WI 53151, U.S.A.
Phone: (800) YASKAWA (800-927-5292) Fax: (262) 782-3418
Internet: http://www.drives.com

YASKAWA ELECTRIC AMERICA, INC.
Chicago-Corporate Headquarters
2121 Norman Drive South, Waukegan, IL 60085, U.S.A.
Phone: (800) YASKAWA (800-927-5292) Fax: (847) 887-7310
Internet: http://www.yaskawa.com

MOTOMAN INC.
805 Liberty Lane, West Carrollton, OH 45449, U.S.A.
Phone: (937) 847-6200 Fax: (937) 847-6277
Internet: http://www.motoman.com

YASKAWA ELECTRIC CORPORATION
New Pier Takeshiba South Tower, 1-16-1, Kaigan, Minatoku, Tokyo, 105-0022, Japan
Phone: 81-3-5402-4511 Fax: 81-3-5402-4580
Internet: http://www.yaskawa.co.jp

YASKAWA ELETRICO DO BRASIL COMERCIO LTDA.
Avenida Fagundes Filho, 620 Bairro Saude Sao Paolo-SP, Brasil CEP: 04304-000
Phone: 55-11-5071-2552 Fax: 55-11-5581-8795
Internet: http://www.yaskawa.com.br

YASKAWA ELECTRIC EUROPE GmbH
Am Kronberger Hang 2, 65824 Schwalbach, Germany
Phone: 49-6196-569-300 Fax: 49-6196-888-301

MOTOMAN ROBOTICS AB
Box 504 S38525, Torsas, Sweden
Phone: 46-486-48800 Fax: 46-486-41410

MOTOMAN ROBOTEC GmbH
Kammerfeldstrabe 1, 85391 Allershausen, Germany
Phone: 49-8166-900 Fax: 49-8166-9039

YASKAWA ELECTRIC UK LTD.
1 Hunt Hill Orchardton Woods Cumbernauld, G68 9LF, Scotland, United Kingdom
Phone: 44-12-3673-5000 Fax: 44-12-3645-8182

YASKAWA ELECTRIC KOREA CORPORATION
Paik Nam Bldg. 901 188-3, 1-Ga Euljiro, Joong-Gu, Seoul, Korea
Phone: 82-2-776-7844 Fax: 82-2-753-2639

YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.
Head Office: 151 Lorong Chuan, #04-01, New Tech Park Singapore 556741, Singapore
Phone: 65-282-3003 Fax: 65-289-3003

TAIPEI OFFICE (AND YATEC ENGINEERING CORPORATION)
10F 146 Sung Chiang Road, Taipei, Taiwan
Phone: 886-2-2563-0010 Fax: 886-2-2567-4677

YASKAWA JASON (HK) COMPANY LIMITED
Rm. 2909-10, Hong Kong Plaza, 186-191 Connaught Road West, Hong Kong
Phone: 852-2803-2385 Fax: 852-2547-5773

BEIJING OFFICE
Room No. 301 Office Building of Beijing International Club,
21 Jianguomanwai Avenue, Beijing 100020, China
Phone: 86-10-6532-1850 Fax: 86-10-6532-1851

SHANGHAI OFFICE
27 Hui He Road Shanghai 200437 China
Phone: 86-21-6553-6600 Fax: 86-21-6531-4242

SHANGHAI YASKAWA-TONJI M & E CO., LTD.
27 Hui He Road Shanghai 200437 China
Phone: 86-21-6533-2828 Fax: 86-21-6553-6677

BEIJING YASKAWA BEIKE AUTOMATION ENGINEERING CO., LTD.
30 Xue Yuan Road, Haidian, Beijing 100083 China
Phone: 86-10-6232-9943 Fax: 86-10-6234-5002

SHOUGANG MOTOMAN ROBOT CO., LTD.
7, Yongchang-North Street, Beijing Economic & Technological Development Area,
Beijing 100076 China
Phone: 86-10-6788-0551 Fax: 86-10-6788-2878

YEA, TAICHUNG OFFICE IN TAIWAIN
B1, 6F, No.51, Section 2, Kung-Yi Road, Taichung City, Taiwan, R.O.C.
Phone: 886-4-2320-2227 Fax:886-4-2320-2239

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