UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER I
SESI 2009/2010

NAMA MATA PELAJARAN	:	TEKNOLOGI PENGAWALAN PEMBUATAN
KOD MATA PELAJARAN	:	BDD 4083
KURSUS	:	BDD
TARIKH PEPERIKSAAN	:	NOVEMBER 2009
JANGKA MASA	:	3 JAM
ARAHAN	:	JAWAB LIMA (5) SOALAN SAHAJA DARIPADA LAPAN (8) SOALAN.

KERTAS SOALAN INI MENGANDUNGI LIMA BELAS (15) MUKA SURAT BERCETAK

S1 Soalan 1 adalah berdasarkan **Rajah S1** di lampiran.

(a) Kenalpasti bilangan masukan (*input*) dan keluaran (*output*) untuk sistem mesin suntikan beracuan seperti yang terdapat dalam **Rajah S1**.

(6 markah)

(b) Berdasarkan *input* dan *output* yang diperolehi di atas, terbitkan gambarajah blok bagi setiap sub unit pada sistem mesin suntikan beracuan tersebut. Anggap setiap satu unit tersebut dikawal oleh satu Pengawal Aturcara Logik (*Programmable Logic Controller –PLC*).

(6 markah)

(c) Jika hanya satu PLC digunakan untuk mengawal keseluruhan sistem tersebut, hasilkan gambarajah skematik sistem kawalan yang sesuai. Cadangkan spesifikasi PLC yang digunakan. Spesifikasi PLC yang digunakan termasuklah;

i. Bilangan I/O (Analog? Digital?)
ii. Bilangan bit PLC
iii. Bekalan bezaupaya dan arus setiap I/O
iv. Jenis komunikasi yang digunakan untuk penghantaran data

Jadual 1 dan 2 dilampiran boleh digunakan untuk mendapatkan maklumat lanjut.

(8 markah)

S2 (a) Berikan perbezaan di antara pengawal mikro (*microcontroller*) dan pemproses mikro (*microprocessor*).

(5 markah)

(b) Namakan LIMA (5) jenis asas nombor yang digunakan dalam memori PLC.

(5 markah)

(c) Turutan pergerakan dua silinder dua tindakan adalah seperti berikut:

A+ B+ B- A- A+ A-
B+ B-

Dengan menganggap sistem tersebut menggunakan injap kawalan arah laluan 5/2 (*5/2 way directional control valve)* satu solenoid bagi kedua-dua silinder, binakan program *ladder logic diagram* untuk kawalan pergerakan tersebut.

(10 markah)

S3 Soalan 3 berdasarkan **Rajah S2**.

(a) Satu silinder pneumatik satu tindakan menolak beban berjisim **M** kg seperti dalam **Rajah S2**. Silinder tersebut akan diundurkan ke belakang oleh satu spring yang mempunyai kekenyalan **C** N/m. Nilai redaman ialah k_d N s/m. Tekanan udara termampat ialah **P** N/m^2 dan luas permukaan dalam silinder ialah **A** m^2. Posisi beban ialah **X** meter setelah ditolak.

Buktikan rangkap pindah sistem ini ialah:

$$\frac{X}{P}(s) = \frac{A/M}{\left(s^2 + 2\delta\omega_n s + \omega_n^2\right)}$$

ω_n ialah frekuensi tabii sistem $(C/M)^{1/2}$

δ ialah nisbah redaman di mana $\delta = \dfrac{k_d}{\sqrt{(4MC)}}$

(10 markah)

(b) Diberi M = 50kg, k_d = 80 N s/m, C = 2000 N/m dan A = 0.2 m^2. Tentukan nilai frekuensi tabii dan nisbah redaman sistem ini.

(6 markah)

(c) Kirakan '*natural gain*' dan pemalar masa untuk sistem ini.

(4 markah)

S4 (a) Berikan perbezaan di antara komunikasi sesiri (*serial communication*) dengan komunikasi selari (*parallel communication*).

(4 markah)

(b) Dengan berbantukan contoh dan lakaran yang sesuai, berikan analisis kelebihan dan kekangan sistem komunikasi terbuka (*open system communication*) dalam operasi pembuatan yang tangkas.

(6 markah)

(c) Soalan ini merujuk kepada **Rajah S3**.

Berdasarkan **Rajah S3**, binakan arkitektur sistem yang sesuai. Pertimbangkan kesesuaian topologi jaring, aras penggunaan pengawal, jenis komunikasi dan keperluan pemantauan data sekiranya terdapat perkongsian data melalui internet (*internet data sharing*). Gunakan **Jadual 3** seperti di lampiran jika perlu.

(10 markah)

S5 (a) Mesin Kawalan Numerik *(Numerical Control –NC)* mempunyai beberapa kelebihan dari segi kos pembuatan seperti masa pendahuluan pembuatan yang lebih singkat, kadar bahan buangan yang rendah dan pengurangan dari segi penggunaan ruang lantai. Walau bagaimanapun, dalam keadaan yang bertentangan, terdapat beberapa komitmen yang akan menyebabkan penambahan kos kepada syarikat. Huraikan keburukan Mesin Kawalan Numerik ini terhadap kos syarikat.

(8 markah)

(b) Garisluar satu bahagian seperti dalam **Rajah S4** akan digerudi sebanyak 3 lubang. Dengan andaian bucu luaran di bahagian permulaan bahan kerja telah dipotong secara kasar dengan menggunakan gergaji jig, dan bahagian ini juga sedikit besar saiznya, 3 lubang yang digerudi ini akan digunakan untuk meletakkan dan menetapkan bahagian ini untuk pengisaran profil yang seterusnya. Sebatang gerudi berdiamter 7.0 mm telah diragum pada penekan gerudi Komputer Kawalan Numerik *(Conputerized Numerical Control –CNC)* dan gerudi ini beroperasi pada suapan 0.05 mm/putaran , dan laju gelendong sebanyak 1000 putaran per minit. Gunakan bahagian sudut bawah kiri sebagai asalan dalam sistem paksi x-y. Pada permulaan kerja, titik penggerudian akan diletakkan pada titik sasaran di koordinat x = 0, y = -50 and z = +10. Tuliskan program bahagian ini dalam bentuk format alamat *word* (*word address format*) dengan pengasingan TAB.

(12 markah)

S6 (a) Senaraikan TIGA (3) contoh jenis-jenis pembuatan fleksibel. Bagi setiap jenis, nyatakan definisi dan faktor-faktor kebergantungan yang mempengaruhi pemilihan jenis pembuatan fleksibel tersebut

(9 markah)

(b) Nyatakan ENAM (6) objektif bagi Sistem Penyimpanan dan Pengambilan Automatik (*Automated Storage Retrieval System -ASRS*) bagi sesebuah syarikat.

(6 markah)

(c) Pilih satu jenis alat pengangkut (*conveyor*) yang sesuai untuk operasi pembungkusan. Pertimbangkan kenapa alat pengangkut ini digunakan untuk aplikasi tersebut.

(5 markah)

S7 (a) Nyatakan LIMA (5) contoh aplikasi Kawalan Numerik *(Numerical Control-NC)* dalam bidang pembuatan.

(5 markah)

(b) Senaraikan TIGA (3) contoh format blok / pita yang digunakan dalam program Kawalan Numerik *(Numerical Control –NC)*

(3 markah)

(c) Satu kelebihan mesin CNC adalah keupayaannya untuk menjalankan strategi kawalan penyesuaian (*adaptive control strategy*) yang mampu mengawal parameter pembuangan bahan (contohnya pemotongan) dalam masa sebenar (*real time*). Bincangkan keadaan-keadaan yang perlu untuk menjalankan proses tersebut dari segi pemerhatian persekitaran bahan buang, pemprosesan signal dan keupayaan untuk membuat keputusan dalam masa sebenar (*decision making in real time*) untuk menukarkan parameter input.

(12 markah)

S8 (a) Huraikan dengan ringkas EMPAT (4) prinsip Pengendalian Bahan (*Material Handling).*

(8 marks)

(b) Salah satu jenis Penangkap Data Automatik *(Automatic Data Capture -ADC)* atau juga dikenali sebagai Penangkap Data dan Identifikasi Automatik *(Automatic Identification and Data Capture -AIDC*) adalah Identifikasi Frekuensi Radio*(Radio Frequency Identification -RFID).* Senaraikan DUA (2) kelebihan teknologi RFID ini.

(4 markah)

(c) Kekurangan RFID dalam sistem pembuatan adalah perkakasannya lebih mahal dari kebanyakan teknologi ADC. Atas sebab tersebut, pemilihan teknologi ini memerlukan beberapa justifikasi. Nyatakan DUA (2) justifikasi dan berikan contoh di mana teknologi ini boleh digunakan.

(8 markah)

TERJEMAHAN

Q1 Question 1 is based on the **Rajah S1** in attachment.

(a) Identify the number of inputs and outputs for the injection moulding machine system as shown in **Rajah S1.**

(6 marks)

(b) According to the above inputs and outputs, derive a block diagram for every sub units in the injection moulding machine. Assume every sub units are controlled by a PLC.

(6 marks)

(c) If only one PLC is used to control the whole system, generate the suitable schematic control system diagram. Suggest the PLC specification used in the system. The PLC specification includes:

i. Number of I/O (Analog? Digital?)
ii. Number of PLC bit
iii. Voltage supply and current for each I/O
iv. Type of communication for data transfer

Please refer to **Jadual 1 and 2** for further information.

(8 marks)

Q2 (a) Compare the differences between microcontroller and microprocessor.

(5 marks)

(b) Name FIVE (5) types of number bases that used in PLC memory.

(5 marks)

(c) The sequence motion of two double acting cylinders is as the following;

A+ B+ B- A- A+ A-
B+ B-

Assuming the system use only single solenoid 5/2 way direction control valve for both cylinders, construct the ladder logic diagram programme to control the sequence.

(10 marks)

Q3 (a) A single acting cylinder has to push a mass **M** kg as shown in **Rajah S2**. The cylinder is returned by a spring with a stiffness **C** N/m. There is damping of k_d N s/m. The compressed air pressure is **P** N/m^2 and the piston area is **A** m^2. The position of the mass is **X** meter.

Proof that the transfer function of this system is:

$$\frac{X}{P}(s) = \frac{A/M}{\left(s^2 + 2\delta\omega_n s + \omega_n^2\right)}$$

ω_n is the natural frequency of the system $(C/M)^{1/2}$

δ is the damping ratio where the $\delta = \frac{k_d}{\sqrt{(4MC)}}$

(10 marks)

(b) Given = 50kg, k_d = 80 N s/m, C = 2000 N/m and A = 0.2 m^2. Determine the natural frequency and the damping ratio of this system.

(6 marks)

(c) Calculate natural gain and time constant of this system.

(4 marks)

Q4 (a) Give the difference between '*serial communication*' and '*parallel communication*'.

(4 marks)

(b) Aided with necessary example and sketches, analyze the advantages and the limitations of "open system communication" in an agile manufacturing operation.

(6 marks)

(c) This question refers to **Rajah S3.**

According to **Rajah S3**, build the suitable system's architecture. Consider the suitability of network topology, level of controller application, communication types and data monitoring requirement if there is data sharing via internet. Use **Jadual 1** if necessary.

(10 marks)

Q5 (a) NC machine has several advantages in terms of manufacturing cost such as shorter manufacturing lead times, lower scrap rates and less floor space required. However in the opposite way, there are also several commitments which involve additional cost to the company. Explain the disadvantages of NC machine towards manufacturing cost

(8 marks)

(b) The outline of the part in **Rajah S4** is to be drilled at 3 holes. By assuming that the outside edges of the starting work part have been rough cut by using jig saw, and the object was slightly oversized, the three drilled holes will be used for locating and fixture the part for subsequent profile milling. A 7.0 mm diameter drill has been chucked in the CNC drill press and the drill will be operated at a feed of 0.05 mm/rev and a spindle speed of 1000 rev/min. Use the lower left corner of the part as the origin in the x-y axis system. At the beginning of the job, the drill point will be positioned at the target point located at coordinate x = 0, y = -50 and z = +10. Write the part program in the word address format with TAB separation. (all units in millimetres).

(12 marks)

Q6 (a) Give THREE (3) examples of manufacturing flexibility types. For each type, provide the definition and the dependant factors which influence the selection of manufacturing flexibility type.

(9 marks)

(b) Define at least SIX (6) Automated Storage Retrieval System (ASRS) possible objectives for a company's storage operation.

(6 marks)

(c) Select one type of conveyor which is suitable for packaging operation. Justify why that conveyor was chosen for this application.

(5 marks)

Q7 (a) List out FIVE (5) examples of Numerical Control (NC) application in manufacturing.

(5 marks)

(b) Give THREE (3) examples of block format /tape format used in NC Programming.

(3 marks)

(c) An important beneficial feature of CNC machine tools is the potential of implementing an adaptive control strategy that would regulate the material removal (i.e., cutting) parameters in real time. Discuss the necessary conditions for such an implementation in terms of monitoring the material removal environment, signal processing, and decision making for making (real time) changes in input parameters.

(12 marks)

Q8 (a) Describe in brief FOUR (4) principles of Material Handling.

(8 marks)

(b) One type of Automatic Data Capture (ADC) or also known as Automatic Identification and Data Capture (AIDC) is Radio Frequency Identification (RFID). List down TWO (2) advantages of RFID technology.

(4 marks)

(c) The disadvantage of RFID in manufacturing system is the hardware tends to be more expensive than for most other ADC technologies. For this reason, the selection of this technology requires several justifications. Provide TWO (2) justifications and give example where this technology can be applied.

(8 marks)

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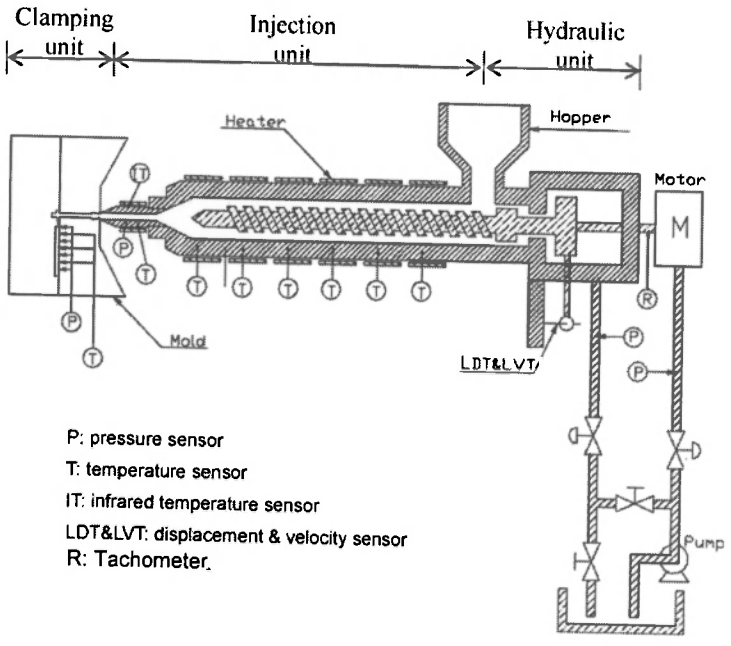
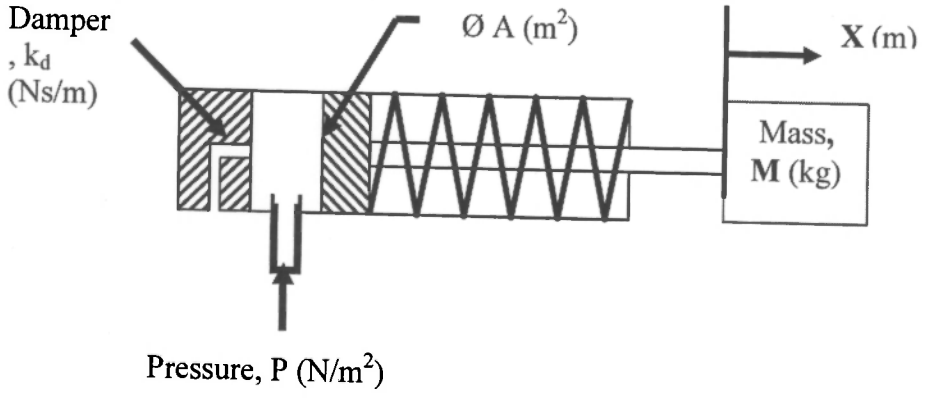


Rajah SI: Injection Moulding Schematic Diagram



Rajah S2

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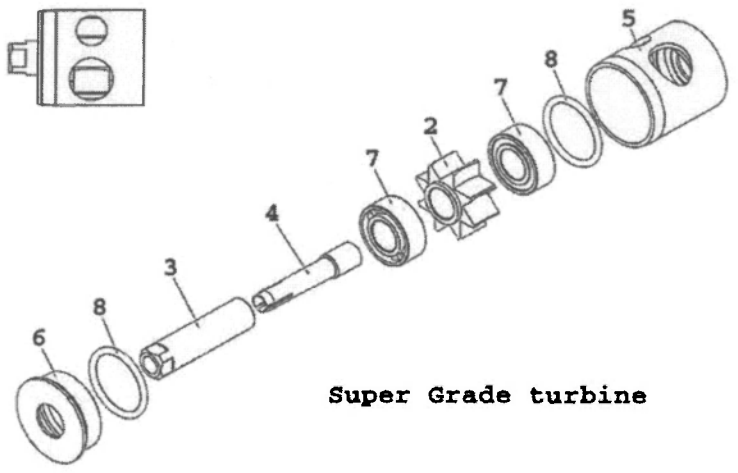

Super Grade turbine

Part no.	Name	Material	Manufacturing
8	O ring	Rubber	Thermoforming
7	Bearing	Steel	Roll and forge
6	Top cover	Aluminum alloy	Diecasting
5	Casing	Aluminum alloy	Diecasting
4	Link shaft	PMMA	Injection moulding
3	Drive shaft	PMMA	Injection moulding
2	Gear	Polyethylene	Inkection moulding

University Tun Hussein Onn Malaysia		Time: 16:00:01	Title: Super grade turbine
		Date: 28 December 2009	
Faculty of Mechanical and Manufacturing Engineering	Drawn by: Mubn Shekaz Checked by: Les Du Gicnac	Ratio: 1 : 1 / Unit: inch	Dwg. No.: TXT/001/8RS/002

Rajah S3

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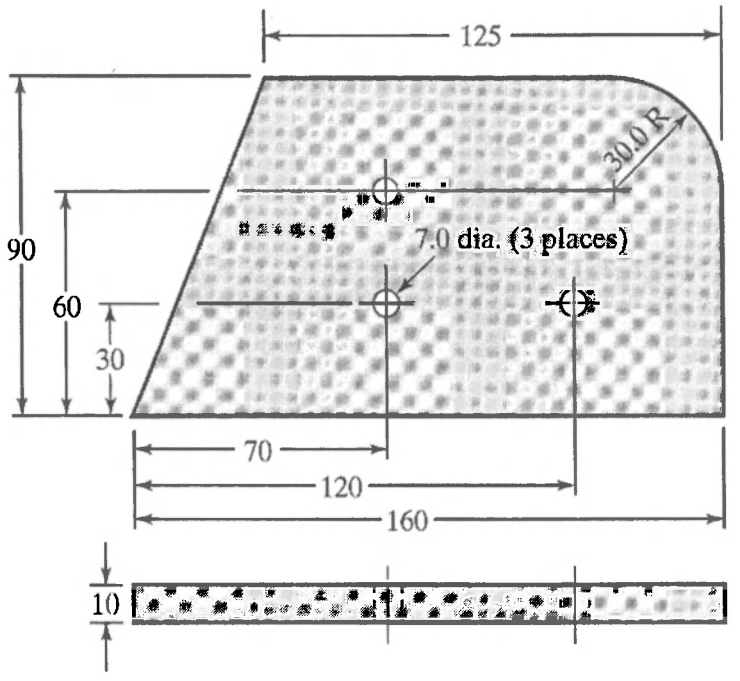

Rajah S4

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Jadual 1

International Standards
* The standards indicated in the "Standards" column are those current for UL, CSA, cULus, NK, and Lloyd standards and EC Directives as of the end of October 2006. The standards are abbreviated as follows:U: UL, U1: UL (Class I Division 2 Products for Hazardous Locations), C: CSA, UC: cULus, UC1: cULus (Class I Division 2 Products for Hazardous Locations), CU: cUL, N: NK, L: Lloyd, and CE: EC Directives.
* Ask your OMRON representative for the conditions under which the standards were met.

■ CPU Units

CPU Unit	Specifications				Model	Standards
	Power supply	Output method	Inputs	Outputs		
CP1H-X CPU Units Memory capacity: 20 Ksteps High-speed counters: 100 kHz, 4 axes Pulse outputs: 100 kHz, 4 axes (Models with transistor outputs only)	AC power supply	Relay output (No pulse output)	24	16	CP1H-X40DR-A	CE, N, L, UC1
	DC power supply	Transistor output (sinking)			CP1H-X40DT-D	CE, N, L, UC1
		Transistor output (sourcing)			CP1H-X40DT1-D	CE, N, L, UC1
CP1H-XA CPU Units Memory capacity: 20 Ksteps High-speed counters: 100 kHz, 4 axes Pulse outputs: 100 kHz, 4 axes (Models with transistor outputs only) Analog inputs: 4 Analog outputs: 2	AC power supply	Relay output	24	16	CP1H-XA40DR-A	CE, N, L, UC1
	DC power supply	Transistor output (sinking)			CP1H-XA40DT-D	CE, N, L, UC1
		Transistor output (sourcing)			CP1H-XA40DT1-D	CE, N, L, UC1
CP1H-Y CPU Units Memory capacity: 20 Ksteps High-speed counters: 1 MHz, 2 axes 100 kHz, 2 axes Pulse outputs: 1 MHz, 2 axes 100 kHz, 2 axes	DC power supply	Transistor output (sinking)	12 + line-driver input, 2 axes	8 + line-driver input, 2 axes	CP1H-Y20DT-D	CE, N

■ Options (for CPU Units)

Name	Specifications	Model	Standards
RS-232C Option Board	For CPU Unit option port.	CP1W-CIF01	CE, N, L, UC1
RS-422A/485 Option Board	For CPU Unit option port.	CP1W-CIF11	CE, N, L, UC1
Memory Cassette	Can be used for backing up programs or auto-booting.	CP1W-ME05M	CE, N, L, UC1

■ Expansion Units

Name	Output method	Inputs	Outputs	Model	Standards
Expansion I/O Units	Relay	24	16	CPM1A-40EDR	CE, N, L
	Transistor (sinking)			CPM1A-40EDT	CE, N, L
	Transistor output (sourcing)			CPM1A-40EDT1	CE, N, L
	Relay	12	8	CPM1A-20EDR1	U, C, CE
	Transistor (sinking)			CPM1A-20EDT	U, C, N, CE
	Transistor output (sourcing)			CPM1A-20EDT1	U, C, N, CE
	—	8	—	CPM1A-8ED	U, C, N, CE
	Relay	—	8	CPM1A-8ER	U, C, N, CE
	Transistor (sinking)	—	8	CPM1A-8ET	U, C, N, CE
	Transistor output (sourcing)			CPM1A-8ET1	U, C, N, CE
Analog Input Unit	Analog (resolution: 1/6000)	4	—	CPM1A-AD041	U, C, N, CE
Analog Output Unit	Analog (resolution: 1/6000)	—	4	CPM1A-DA041	UC1, CE
Analog I/O Units	Analog (resolution: 1/256)	2	1	CPM1A-MAD01	UC1, CE
	Analog (resolution: 1/6000)	2	1	CPM1A-MAD11	U, C, N, CE
DeviceNet I/O Link Unit	—	32 (I/O link input bits)	32 (I/O link input bits)	CPM1A-DRT21	U, C, CE
CompoBus/S I/O Link Unit	—	8 (I/O link input bits)	8 (I/O link input bits)	CPM1A-SRT21	U, C, N, CE
Temperature Sensor Units	2 thermocouple inputs			CPM1A-TS001	U, C, N, CE
	4 thermocouple inputs			CPM1A-TS002	U, C, N, CE
	2 platinum resistance thermometer inputs			CPM1A-TS101	U, C, N, CE
	4 platinum resistance thermometer inputs			CPM1A-TS102	U, C, N, CE

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Jadual 2

Expansion I/O

Analog Input Unit
CPM1A-AD041

Item		CPM1A-AD041	
		Input voltage	Input current
Number of inputs		4	
Input signal range		0 to 5 V, 1 to 5 V, 0 to 10 V, or -10 to 10 V	0 to 20 mA or 4 to 20 mA
Max. rated input		±15 V	±30 mA
External input impedance		1 MΩ min.	Approx. 250 Ω
Resolution		6000	
Overall accuracy	25°C	±0.3% of full scale	±0.4% of full scale
	0 to 55°C	±0.6% of full scale	±0.8% of full scale
Conversion time		2.0 ms/point	
A/D conversion data		Binary data with resolution of 6,000 Full scale for -10 to 10 V: F448 (E890) to 0BB8 (1770) hex Full scale for other ranges: 0000 to 1770 (2EE0) hex	
Averaging		Supported	
Open-circuit detection		Supported	
Insulation resistance		20 MΩ min. (at 250 VDC, between isolated circuits)	
Dielectric strength		500 VAC for 1 min (between isolated circuits)	
Isolation method		Photocoupler isolation (between analog inputs and secondary internal circuits). No isolation between input signals.	

Analog Output Unit
CPM1A-DA041

Item		CPM1A-DA041	
		Input voltage	Input current
Number of outputs		4	
Output signal range		0 to 5 V, 0 to 10 V, or -10 to 10 V	0 to 20 mA or 4 to 20 mA
Allowable external output load resistance		2 kΩ min.	350 Ω max.
External output impedance		0.5 Ω max.	—
Resolution		6000	
Overall accuracy	25°C	±0.4% of full scale	
	0 to 55°C	±0.8% of full scale	
Conversion time		2.0 ms/point	
D/A conversion data		Binary data with resolution of 6,000 Full scale for -10 to 10 V: F448 (E890) to 0BB8 (1770) hex Full scale for other ranges: 0000 to 1770 (2EE0) hex	
Insulation resistance		20 MΩ min. (at 250 VDC)	
Dielectric strength		500 VAC for 1 min between isolated circuits	
Isolation method		Photocoupler isolation between analog inputs and secondary internal circuits. No isolation between analog input signals.	

Analog I/O Units
CPM1A-MAD01/MAD11

Item			CPM1A-MAD01		CPM1A-MAD11	
			Voltage I/O	Current I/O	Voltage I/O	Current I/O
Analog Input Section	Number of inputs		2 inputs		2 inputs	
	Input signal range		0 to 10 V, 1 to 5 V	4 to 20 mA	0 to 5 V, 1 to 5 V, 0 to 10 V, or -10 to 10 V	0 to 20 mA, 4 to 20 mA
	Max. rated input		±15V	±30mA	±15V	±30mA
	External input impedance		1 MΩ min.	250 Ω rated	1 MΩ min.	250Ω
	Resolution		1/256		1/6000 (full scale)	
	Overall accuracy	25°C	1.0% of full scale		±0.3% of full scale	±0.4% of full scale
		0 to 55°C			±0.6% of full scale	±0.8% of full scale
	A/D conversion data		8-bit binary		Binary data (hexadecimal, 4 digits) -10 to 10 V: F448 to 0BB8 hex Full scale for other ranges: 0000 to 1770 hex	
Analog Output Section (See note 1.)	Averaging		—		Supported (Set for each input using a DIP switch.)	
	Disconnection detection		—		Supported	
	Number of outputs		1 output		1 output	
	Output signal range		0 to 10 V, -10 to 10 V	4 to 20 mA	1 to 5 V, 0 to 10 V, -10 to 10 V	0 to 20 mA, 4 to 20 mA
	External output max. current		5 mA	—	—	—
	Allowable external output load resistance		—	350 Ω	1 kΩ min.	600 Ω max.
	External output impedance		—		0.5 Ω max.	—
	Resolution		1/256 (1/512 for output signal range -10 to 10 V)		1/6,000 (full scale)	
	Overall accuracy	25°C	1.0% of full scale		±0.4% of full scale	
		0 to 55°C			±0.8% of full scale	
	Data setting		8-bit binary with sign bit		—	
	D/A set data		—		Binary data (hexadecimal, 4 digits) -10 to 10 V: F448 to 0BB8 hex Full scale for other ranges: 0000 to 1770 hex	
Conversion time			10 ms/Unit max. (See note 2.)		2 ms/point (6 ms for all points)	
Isolation method			Photocoupler isolation between I/O terminals and PLC signals (There is no isolation between the analog I/O signals.)		Photocoupler isolation between analog I/O and internal circuits (There is no isolation between the analog I/O signals.)	

Note 1: The voltage output and current output can be used at the same time for analog outputs, but the total output must not exceed 21 mA. 2: The conversion time is the total time for 2 analog inputs and 1 analog output.
2: The conversion time is the total time for 2 analog inputs and 1 analog output.

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JADUAL 3

Network	topology	addresses	length	speed	packet size
Bluetooth	wireless	8	10	64Kbps	continuous
CANopen	bus	127	25m-1000m	1Mbps-10Kbps	8 bytes
ControlNet	bus or star	99	250m-1000m wire, 3-30km fiber	5Mbps	0-510 bytes
Devicenet	bus	64	500m	125-500Kbps	8 bytes
Ethernet	bus, star	1024	85m coax, 100m twisted pair, 400m-50km fiber	10-1000Gbps	46-1500bytes
Foundation Fieldbus	star	unlimited	100m twisted pair, 2km fiber	100Mbps	<=1500 bytes
Interbus	bus	512	12.8km with 400m segments	500-2000 Kbps	0-246 bytes
Lonworks	bus, ring, star	32,000	<=2km	78Kbps-1.25Mbps	228 bytes
Modbus	bus, star	250	350m	300bps-38.4Kbps	0-254 bytes
Profibus	bus, star, ring	126	100-1900m	9.6Kbps-12Mbps	0-244bytes
Sercos	rings	254	800m	2-16Mbps	32bits
USB	star	127	5m	>100Mbps	1-1000bytes