Table 2 - Typical Module Scan Times

Module		Scan
T9402	Digital input module, 24 Vdc, 16 channel Simplex Dual Triple	 0.924 ms 1.676 ms 2.453 ms
T9432	Analogue input module 24 Vdc, 16 channel Simplex Dual Triple	 1.170 ms 1.965 ms 2.656 ms
T9451	Digital output module, 24 Vdc, 8 channel Simplex Dual	 1.174 ms 2.202 ms
T9482	Analogue output module, 24 Vdc, 8 channel Simplex Dual	 0.981 ms 1.761 ms
	Minimum cycle time overhead	39.3 ms
	Scan overhead for each module	0.04 ms

The scan time is:

Scan time = 39.3 ms (minimum cycle time overhead)

+ Sync time

+ Total number of modules * 0.04 ms

+ Σ (Number of module groups x scan time shown above)

Where:

Sync time is a function of the total number of modules defined according to the following table:

0..10 modules	20 ms
11..20 modules	22 ms
21..30 modules	24 ms
31..40 modules	27 ms
41..48 modules	32 ms.

Though the average scan time will be within 1 ms of the scan time calculated above the calculation does not take into account the effects of application logic and network communication, and individual scans can vary by up to +/- 4 ms around the average scan time.

Throughput time is the time from input change to output action. For asynchronous inputs the throughput times can be derived from the Scan time calculated above according to the following formula:

- Minimum throughput time = Scan period + 7 ms
- Maximum throughput time = 2 x Scan time + 13 ms

EXAMPLE: An example configuration scan time:

System configuration includes T9432 Analogue input simplex modules x 30 and T9451 Digital output simplex modules x 18.

Installation Requirements for Non-Hazardous Environment

Investigation File Number E341697

Products Covered

The products investigated and approved:

Programmable Logic Controller Models:

- T9110 Processor Module
- T9401 Digital Input Module
- T9402 Digital Input Module, 16 Channel
- T9431 Analogue Input Module
- T9432 Analogue Input Module, 16 Channel
- T9451 Digital Output Module
- T9481 Analog Output Module
- T9482 Analogue Output Module, 8 Channel.

Listed Accessories for use with PLCs:

- T9100 Processor Backplane
- T9300 I/O Backplane
- T9801 Digital Input Termination Assembly, Simplex
- T9802 Digital Input Termination Assembly, Dual
- T9803 Digital Input Termination Assembly, TMR
- T9831 Analogue input Termination Assembly, Simplex
- T9832, Analogue Input Termination Assembly, Dual
- T9833 Analogue Input Termination Assembly, TMR
- T9851 Digital Output Termination Assembly, Simplex and T9852 Digital Output Termination Assembly, Dual
- T9892 Digital Output Termination Assembly, Dual
- T9881 Analogue Output Termination Assembly, Simplex
- T9882 Analogue Output Termination Assembly, Dual.

Table 5 - Maximum Electrical Rating Values

Module	Back-plane Electrical Ratings		Input/Output Electrical Ratings
	Voltage Range (Vdc)	Maximum Current (mA)	
T9100	18-32	10.4A (400 mA per slot)	-
T9300	18-32	9.6A (400 mA per slot)	-
T9110	18-32	380	-
T9401	18-32	260	Input: 18-32 Vdc @ 24 mA
T9402	18-32	260	Input: 0-32 Vdc @ 6.5 mA
T9431	18-32	260	Input: 0-32 Vdc @ 6.5 mA
T9432	18-32	260	Input: 18-32 Vdc @ 24 mA
T9481	18-32	260	Output: 18-32 Vdc/0-20 mA
T9482	18-32	260	Output: 18-32 Vdc/0-20 mA
T9451	18-32	165	Output: 18-32 Vdc @ 0.5 A, Pilot duty 16 VA, 1.5 A Inrush
T9801	18-32	6.5	-
T9802	18-32	6.5	-
T9803	18-32	6.5	-
T9831	18-32	0-24	-
T9832	18-32	0-24	-
T9833	18-32	0-24	-
T9851	18-32	500	-
T9852	18-32	500	-
T9892	18-32	500	-
T9881	18-32	0-24	-
T9882	18-32	0-24	-

Expansion Cable

This is used to add extra rows of I/O base units and modules.

Table 6 - Module Supply Power Consumption

Item	Number of Modules	Power Consumption	Subtotal
T9110 Processor Module		× 8.0 W	=
T9401 Digital Input Module 24 Vdc, 8 channel		× 3.3 W	=
T9402 Digital Input Module 24 Vdc, 16 channel		× 4.0 W	=
T9431 Analogue Input Module, 8 channel		× 3.3 W	=
T9432 Analogue Input Module, 16 channel		× 4.0 W	=
T9451 Digital Output Module, 24 Vdc, 8 channel		× 3.0 W	=
T9482 Analogue Output Module, 8 channel, isolated		× 3.6 W	=
		Total:	

IMPORTANT The above figures are worst case values calculated from the range of operating voltages and currents. If your system is required to meet UL/CSA standards the power consumption and the corresponding electrical ratings must not exceed the maximum electrical ratings given in the table included in the topic "Backplane Electrical Ratings".

IMPORTANT Les figures précédentes sont des valeurs des pires cas calculées pour la plage des tensions et courants opérationnelles. Si votre système doit rencontrer les normes UL/CSA la consommation en puissance et la caractéristique nominale électrique correspondantes ne doit pas dépasser la caractéristique nominale électrique rapportée par la table de la section "Backplane Electrical Ratings".

Field Power Consumption

To estimate overall controller power dissipation it is necessary to include the field power component dissipated within the controller. Refer to the table "Field Loop Power Heat Dissipation". The field power requirements should be calculated separately and is dependent on the number and type of field elements. Refer to the specifications for the Digital and Analogue output modules for details of the channel output electrical specifications.

System Design Considerations for Heat Dissipation and Cooling

The controller is designed to operate in its specified environment without forced air cooling. However, forced air cooling may be needed in individual circumstances when the controller shares its enclosure with other heat producing equipment and the internal temperature could exceed the recommended operating temperature range.

Module Orientation

Rockwell only recommend that modules are oriented vertically, if modules are mounted in any other orientation, then specific temperature tests must be done to achieve reliable and predictable operation.

Maximum Air Temperature

The maximum air temperature rating in an enclosure where AADvance modules are installed to support predictable operation is 70 °C (158 ° F).

Estimate Heat Dissipation

The heat in the enclosure is generated from several sources such as the power supplies, the AADvance modules and some of the field loop power. Use the following calculation and the data given in the tables to estimate the overall heat dissipation:

- Power supply consumption (Watts x (100-efficiency) (%) + the sum of the system power consumed by the modules + part of the field power that is in the enclosure.

The following module power dissipation values are worst case values over the range of operating voltages and currents.

Table 7 - Module Supply Power Heat Dissipation

Item	Number of Modules	Module Power Heat Dissipation	Subtotal (W/BTU/hr)
T9110 Processor Module		× 8.0 W (27.3 BTU/hr.)	=
T9401 Digital Input Module 24 Vdc, 8 channel		× 3.3 W (11.3 BTU/hr.)	=
T9402 Digital Input Module 24 Vdc, 16 channel		× 4.0 W (13.6 BTU/hr.)	=
T9431 Analogue Input Module, 8 channel		× 3.3 W (11.3 BTU/hr.)	=
T9432 Analogue Input Module, 16 channel		× 4.0 W (13.6 BTU/hr.)	=
T9451 Digital Output Module, 24 Vdc, 8 channel		× 3.0 W (10.2 BTU/hr.)	=
T9482 Analogue Output Module, 8 channel, isolated		× 3.6 W (12.3 BTU/hr.)	=
		Total:	

The field loop power heat dissipation is generated from the input voltages and currents + the output currents:

Table 8 - Field Loop Power Heat Dissipation

Item	Number of Field Loops	Field Loop Power Heat Dissipation	Subtotal (W x 3.412 BTU/hr)
Digital Inputs		× Input Voltage (V)/5125	=
Analogue Inputs		× Input current (A) x 135	=
Digital Outputs		x Output current (A) x 0.57	=
Analogue outputs		x (Field voltage(V) x Output Current (A) - load Resistance (Ω) x Output current (A) [1]	=
		Total:	

[1] The maximum field loop power heat dissipation for analogue outputs should be calculated at an output current corresponding to the smaller of the Maximum Channel Output Current OR Field Voltage/(2 x Load Resistance)

Estimate AADvance Controller Weight

Use the following table to make an estimate of the weight of your controller.

Table 9 - AADvance Controller Module Weight

Item	Number Used	Weight Allowance g (oz.)	Subtotal
T9100 Processor Base Unit		× 460 g (16 oz.)	
T9110 Processor Module		× 430 g (15 oz.)	
T9401 Digital input module, 24 Vdc, 8 channel		× 280 g (10 oz.)	
T9402 Digital input module, 24 Vdc, 16 channel		× 340 g (12 oz.)	
T9431 Analogue input module, 8 channel		× 280 g (10 oz.)	
T9432 Analogue input module, 16 channel		× 340 g (12 oz.)	
T9451 Digital output module, 24 Vdc, 8 channel		× 340 g (12 oz.)	
T9482 Analogue output module, 8 channel		× 290 g (10.5 oz.)	
T9300 I/O base unit (3 way)		× 133 g (5 oz.)	
T98x1 Simplex Termination assembly		× 133 g (5 oz.)	
T98x2 Dual Termination Assembly		× 260 g (10 oz.)	
T98x3 Triple Termination Assembly		× 360 g (13 oz.)	
T9310 Expansion cable assembly and 2 m cable		× 670 g (24 oz.)	
T9841 Termination Assemblies (average weight)		× 175 g (6 oz.)	

Total estimated controller weight	

Estimating Center of Gravity Information

If it is necessary to calculate the location of the center of gravity of an AADvance controller destined for a maritime or other shock-mounted application, it is reasonable to assume the center of gravity of each assembly of modules and their base unit is at the geometric center of the assembly.

Design Considerations for Electrical Grounding

All applications of the controller will require at least two separate ground (earth) systems:

- An AC safety ground (sometimes called the 'dirty ground') to protect people in the event of a fault. The ground stud on the T9100 processor base unit, and all exposed metalwork such as DIN rails, will be bonded to the AC safety ground.
- An instrument ground (sometimes called the 'clean ground' or the '0 Vdc ground') to provide a good stable 0 V reference for the system. Every signal return will be referenced to the instrument ground. The instrument ground will be isolated from the AC safety ground.

The AC safety ground and the instrument ground will usually be made available through bus-bars. Bus-bars must be of copper; they may be nickel plated. For a small application, you may use ground studs instead of bus-bars.

Some field wiring, such as communications cables, will need shielded (screened) cable. There may be a shield ground, in addition to the AC safety and instrument grounds, to provide a common point to terminate shields of such cables. The shield ground will usually be connected to the AC safety ground; or, more rarely, to the instrument ground. In practice, the continuity of the shield connections will be more important than the goodness of the ground connection provided.

Parts List

Base Units

Part No.	Part Description
T9100	Processor base unit
T9300	I/O base unit (3 way)

Modules

Part No.	Part Description
T9110	Processor module
T9401	Digital input module, 24 Vdc, 8 channel, isolated
T9402	Digital input module, 24 Vdc, 16 channel, isolated
T9451	Digital output module, 24 Vdc, 8 channel, isolated, commoned
T9431	Analogue input module, 8 channel, isolated
T9432	Analogue input module, 16 channel, isolated
T9481	Analogue output module, 3 channel, isolated
T9482	Analogue output module, 8 channel, isolated

Special Application Modules

Part No.	Part Description
T9441	Frequency Input Module (Product not yet released. Contact Sales for more information)

Termination Assemblies

Part No.	Part Description
T9801	Digital input TA, 16 channel, simplex, commoned
T9802	Digital input TA, 16 channel, dual
T9803	Digital input TA, 16 channel, TMR
T9831	Analogue input TA, 16 channel, simplex, commoned
T9832	Analogue input TA, 16 channel, dual
T9833	Analogue input TA, 16 channel, TMR
T9851	Digital output TA, 24Vdc, 8 channel, simplex, commoned
T9852	Digital output TA, 24Vdc, 8 channel, dual
T9881	Analogue output TA, 8 channel, simplex commoned