JEM®1 JOULE ELECTRONIC METERS

INSTRUCTION MANUAL

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1 INTRODUCTION

1.1. General Information

This manual contains information about meter operation modes, circuit board location and function, and wiring and mounting information for front- and panel-mounted standard JEM®1 meters. This manual also has information about switchboard and special-type meters. Refer to the JEM1 Maintenance Manual for information for disassembly, test, maintenance, and parts replacement information.

1.2. Functional Description

The JEM1, a Joule Electronic Meter manufactured by Scientific Columbus, is a versatile, highly-accurate, solid-state instrument capable of measuring several different functions of energy. Several meter combinations can be ordered with application-specific functions. Standard functions of energy such as watts, vars, volts, and amperes are available, as are Q, volt-ampere, expanded volts, and current-squared. The plug-in circuit boards and the transformer base orientation are configured accordingly. (See Table 1-1 for available model types.)

Microprocessors in the electronic registers process pulses (generated from the plug-in function cards), calculate demands and interval time, and control the displays. Demands are calculated from the output pulses and are displayed and stored in low-power solid-state memory circuits for data retention. (An electromechanical display register, which consists of mechanical counters to display total consumption, is available without the microprocessor circuitry.)

1.3. Options

The JEM1 meter is available with customized options for specific applications (Table 1-2). Not all options are available on all models. Contact Scientific Columbus Technical Support, at 1-888-880-5361, for option availability.

1.4. Features & Applications

- Multifunction capability saves time, space, and money in installation by reducing the number of instruments required.
- High-accuracy metering under light, heavy, or distorted loads
- Low maintenance
- Long-term stability
- Compact, rugged, lightweight design
- Panel, switchboard, or projection mounting
- Applicable in situations where rotary-type meters may fall short
- No leveling required
- Digital and analog pulse outputs for each function
- Tamper proof
- Back-lit LCD indicators and alpha-numeric display on EXJ option
- Phase-shifting transformers and compensators not required for active measurements
- Recorder compatible
- Internal mass memory and modem options available, to replace external pulse recorders

- Versatile pulse rate within specified range, for direct primary reading
- Time-saving direct reading
- Simplified test with test point, adjustment, and calibration jacks
- Plug-in circuit cards
- Available SC-60 Multifunction MicroJoule standard for JEM1 test and calibration

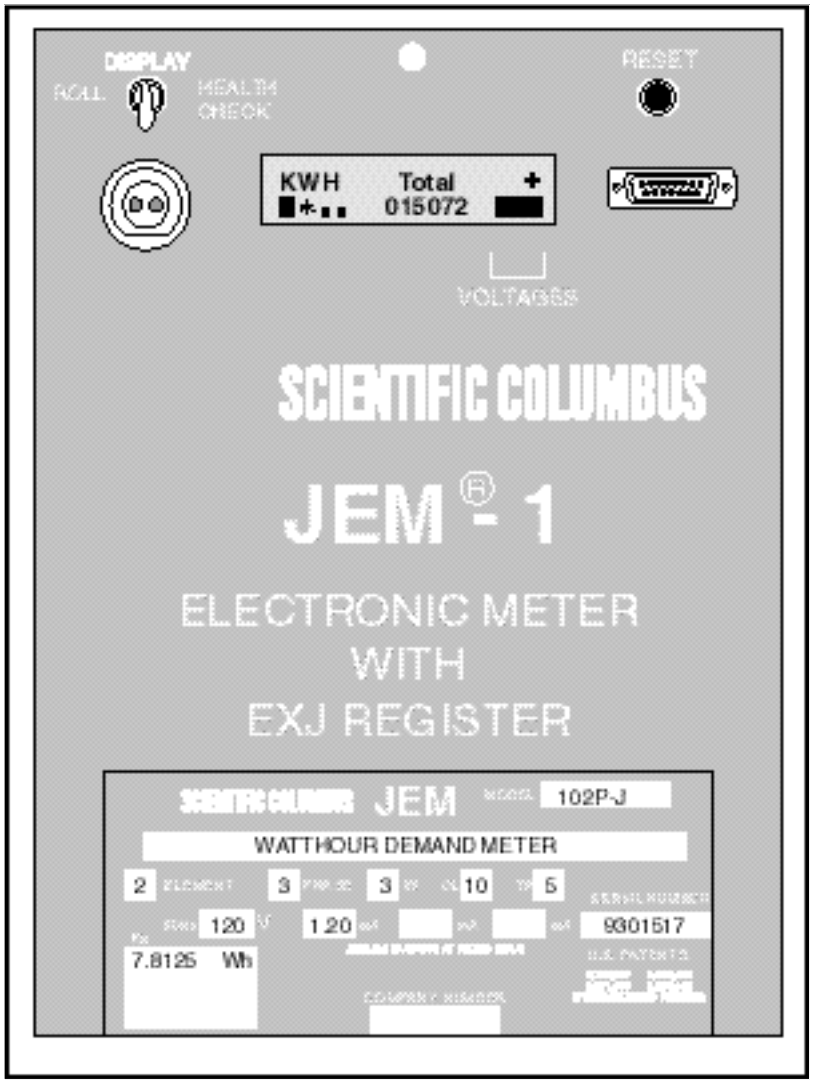


Figure 1-1 JEM1 Meter with EXJ Register

1.5. Specifications

Normal Operating Conditions

NOMINAL INPUTS (REFERENCE POINT)

Watts	600W/element (2-element - 1200W, 2-1/2 element - 2400w @ 5A and, 3-element - 1800W)
Vars	600vars/element (2-element - 1200Vars, 2-1/2 element - 2400Vars @ 5A and, 3-element - 1800Vars)
VA	600VA/element (2-element - 1200VA, 2-1/2 element - 2400VA @ 5A and, 3-element - 1800VA)
Q	600Q/element (2-element - 1200Q 2-1/2 element - 2400Q @ 5A and 3-element - 1800Q)
Volts	120V (per-element potential)
Potential Input	75 to 135V, 120V nominal
Current Input	Zero to 10A load range, 5A nominal
Any Power Factor	Zero lag -- unity -- zero lead
Auxiliary Power	90 to 150Vac, 60 Hz (120V rated meters)
Ambient Temperature	$25^{o}C \pm 5^{o}C$
Frequency	58 to 62 Hz (excluding var functions)
Relative Humidity	5 to 95%, non condensing

INPUTS

Terminals	Barrier-type terminal input blocks with #10-32 screw terminals; nickel/tin-plated brass contacts
Current Input	0 - to-10A load range
Burden	0.2VA per element at 5A nominal
Overload	15A maximum continuous, I^2t maximum of 80,000 A^2s
Potential Input	120V nominal, 75 to 135Vac normal operation range; 20 to 150V extended operation range
Burden	0.05VA at 120V/element
MOV Rating	150V Max (120V rated meters)

(JEM1 meters are equipped with internal metal oxide (MOV) varistors that provide voltage transient protection. A separate MOV is connected across each potential input terminal pair including auxiliary power. These devices will limit line-to-line surges and are useful in all installations where the reference phase is grounded.)

INTERNAL POTENTIAL

Transformer Overload	250V continuous
Auxiliary Power	90 to 135Vac, 60Hz(120V option) 240V or 480Voptions, same ratio
Burden	12VA maximum

ANALOG OUTPUTS

Terminals	B or P option outputs are provided on rear barrier terminal blocks with #8-32 screw contacts. F and SW option outputs are provided on front 25-pin D type connector.
Output Rating	1.2 mA dc at nominal-rated inputs 1.6 mADC for 2 ½ element meters
Ripple	0.25% class peak maximum
Response Time	0.4 seconds to 99% of final value
Load Resistance Max	R_{load} X I_{out} = 10Vdc maximum

Example

(Condition for maximum R_{load} @ 10A and 120V)

R_{load} = 4.16 kilohms maximum at I_{out} = 2.4mA

(The dc analog outputs are bipolar reversing polarity for reverse watts or reverse vars. The negative terminals of the analog outputs are common, electrically the same point, on meters with more than one output.)

Solid-State Pulse Outputs

Type: Three-wire "Form C" Solid-State Contacts

The output device consists of a pair of photo-coupled, solid-state switches in a "Form C" configuration. Generally referred to as K-Y-Z outputs, the initial state is arbitrary, with either K-Y or K-Z closed (conducting) and the other open (non conducting). A pulse (count) results in an exchange of the state of both contacts, the closed side opening and the open side closing. Properly designed receiving equipment will not recognize any other condition as a pulse (count). Loss of auxiliary operating power to the meter will result in both solid-state switches becoming open until power is restored. If the power loss is less than six hours, the output will return to its pre-power-loss state. The solid-state output is photo isolated from the internal circuits and has the following limitations:

Maximum Ratings	V_{CE} (OFF-state maximum volts) 200Vdc or peak ac V_{CE} (SAT) (ON-state voltage drop) 2.5V maximum at 30mA I_C (MAX transistor current) 50mA Current Leakage (OFF state) 1µa maximum

ACCURACY (NORMAL OPERATING CONDITIONS)

Watt /Watthour	±(0.09% Reading +0.01% FS[1])
Var / Varhour	±(0.12% Reading +0.02% FS)
VA /VA Hour	±(0.20% Reading +0.05% FS)
Q/Qhours	(0.09% Reading +0.01% FS)
Amp/Amphour	±(0.09% Reading +0.01% FS)
Amp^2/Amp^2hour	±(0.12% Reading +0.02% FS)
Volt/Volthour/ $Volt^2$/$Volt^2$hour	±0.2% Reading (over normal operation range of 75 to 135Vac.); additional error maximum of 0.1% from 20 to 75V and 135 to 150V

TEMPERATURE INFLUENCE (FROM -20^{O}C TO +70^{O}C):

Watthour/Qhour/ Amphour	.005%/^{O}C maximum
Varhour/Volthour/ Amp^2hour	.009%/^{O}C maximum
VA Hour	0.01%/^{O}C maximum

ZERO-LOAD OPERATION

Pulses	The unit will not produce pulses at registers or pulse outputs at zero-load current.
Starting	Minimum of 0.02 percent of class is required to produce meter operation.

ISOLATION

External Magnetic Field	Less than 0.01% class with 100 ampere-turns produced by a six-foot, straight conductor carrying a current of the same frequency and phase as the applied voltage and positioned in any direction 10 inches from the center of the meter
Inputs	Current, potential, and auxiliary power inputs rated at 2500V rms for one minute
Outputs	KYZ pulse outputs and analog outputs to case are 1000V rms. **NOTE**: Analog outputs are not subject to differential dielectric test.

[1] Full scale--the maximum operating range of a referenced function with specified accuracy. This term is used to replace previous references to percent of class which is somewhat ambiguous. Full scale for a typical 120V Class 10A, 3-element meter is 3600W, vars or VA.

Surge Withstand	Damage to unit or extraneous outputs will not occur when subjected to a test wave of 1.5MHz nominal frequency, with a 2500V crest value for the first half-cycle peak, and decaying to 50 percent of the crest value in not less than five microseconds. The test wave is applied at a repetitive rate of not less than 50 tests per second for a period of not less than 2.0 seconds. (Reference ANSI C37.90a.)

Register Indicators

Load-Rate Indicators	Four flashing indicators indicate relative load. These may be set to operate up to 32 times faster than pulse outputs for light-load indication. These appear on the left side of the electronic display registers and adjacent to the counters on electromechanical registers.
Potential Indicators	Three indicators display the presence of potential input for each element (Mechanical units have green LEDs.) These are located in the register display.

Physical Description

Size	8-15/16" high x 6-11/32" wide x 7-9/16" deep for options B, P, and W. 13-5/16" high x 6-11/32" wide x 7-9/16" deep with option F. (The F-option input plate is attached below the meter case in vertical alignment with the rear of the standard case. The F-option input plate is 1-1/4" deep x 6-11/32" wide x 4-3/8" high. Thus, the overall height of the meter becomes 13-5/16" in the F-option configuration.)
Weight	13 pounds maximum, 10 pounds typical (Weight varies according to type and model.)
Outline Dimensions and Panel Cutouts	See Figure 2-3through 2.7 in the following section.

Table 1-1 JEM1 Model Numbers

Model Number Assignments (Note: Functions not followed by the "h" are analog only and do not have a pulse output.)				
	1 Element	2 Element	3 Element	2-1/2 Element
JEM 100 Series - Single Function (Type 1)				
kWh		JEM 102	JEM 103	JEM 104
kVARh		JEM 112	JEM 113	JEM 114
Vh	JEM 121			
Vh Expanded Scale	JEM 121-09			
Ih	JEM 131	JEM 132	JEM 133	JEM 134
I	JEM 141	JEM 142	JEM 143	JEM 144
kVAh		JEM 152	JEM 153	JEM 154
I^2h	JEM 161	JEM 162	JEM 163	JEM 164
JEM 200 Series - Bidirectional (Type 2)				
±kWh		JEM 202	JEM 203	JEM 204
±kVARh		JEM 212	JEM 213	JEM 214
JEM 300 Series - Dual Function Units (Type 3)				
kWh/kQh		JEM 302	JEM 303	JEM 304
kWh/kVARh (Lag)		JEM 312	JEM 313	JEM 314
±kWh/kVAR		JEM 322	JEM 323	JEM 324
kW/kVAR		JEM 332	JEM 333	JEM 334
kWh/kVAR		JEM 342	JEM 343	JEM 344
kWh/kVAh	JEM 351	JEM 352	JEM 353	JEM 354
kWh/kVARh (Lead)		JEM 362	JEM 363	JEM 364
kVAh/kQh		JEM 372	JEM 373	JEM 374
±kWh/V^2h		JEM 382	JEM 383	JEM 384
kWh/Ih		JEM 392	JEM 393	JEM394
JEM 400 Series - (Type 4)				
kWh /V		JEM 402	JEM 403	JEM 404
±kWh/V		JEM 412	JEM 413	JEM 414
kWh/I (Amp)		JEM 422	JEM 423	JEM 424
±kWh/I		JEM 432	JEM 433	JEM 434
kWh/VAR/V		JEM 442	JEM 443	JEM 444
±kWh/VAR/V		JEM 452	JEM 453	JEM 454
kWh/V/I		JEM 462	JEM 463	JEM 464
±kWh/V/I		JEM 472	JEM 473	JEM 474
kWh/kVA		JEM 482	JEM 483	JEM 484
kWh/kVARh/V		JEM 492	JEM 493	JEM 494

Model Number Assignments (Note: Functions not followed by the "h" are analog only and do not have a pulse output.)				
JEM 500 Series - 3 Function (Type 5)	1 Element	2 Element	3 Element	2-1/2 Element
kWh/Vh/kQh		JEM 502	JEM 503	JEM 504
kWh/V^2h/kQh		JEM 512	JEM 513	JEM 514
kWh/V^2h/kVARh		JEM 522	JEM 523	JEM 524
kWh/Vh/kVAh		JEM 532	JEM 533	JEM 534
kWh/Vh/kVARh		JEM 542	JEM 543	JEM 544
kWh/V/kVARh		JEM 552	JEM 553	JEM 554
±kWh/V^2/I^2 (Comp)		JEM 562	JEM 563	JEM 564
±kVARh/V^2/I^2 (Comp)		JEM 572	JEM 573	JEM 574
kWh/V^2h/I^2h		JEM 582	JEM 583	JEM 584
+kWh(out)/-kWh(in)/kVARh(4 Quad)		JEM 592	JEM 593	JEM 594
JEM 600 Series - (Type 6)				
±kWh/±kVARh		JEM 602	JEM 603	JEM 604
±kWh/kQh		JEM 612	JEM 613	JEM 614
kWh/±kVARh		JEM 622	JEM 623	JEM 624
±kWh/kVAh		JEM 632	JEM 633	JEM 634
±kWh/V^2h/kQh		JEM 642	JEM 643	JEM 644
kWh/Vh/±kVARh		JEM 652	JEM 653	JEM 654
kWh/V^2h/±VARh		JEM 662	JEM 663	JEM 664
±kWh/V^2h/kVARh		JEM 682	JEM 683	JEM 684
±kWh//kVARh		JEM 692	JEM 693	JEM 694
±kWh/V^2h/±kVARh		JEM 702	JEM 703	JEM 704
kWh/V^2h/kVAh		JEM 712	JEM 713	JEM 714
±kWh/V/±kVARh		JEM 722	JEM 723	JEM 724
JEM Special Series -	**N/A**			
V^2h/V^2h/V^2h			JEM 3595	
I^2h/I^2/I^2h			JEM 4094	
Ch 1 Analog/Ch 2 Analog Totalizer	JEM 6368			
KYZ Input 1-4 channel Remote Register	JEM 6590			
I^2h/I^2h/I^2h			JEM 720	
kW/I^2/I^2h			439	
IkWh, Dual Circuit		202.22		
I^2h/I^2h	6812			
I^2h/I^2h	6813			

Table 1-2 JEM1 Options

Option	Modification Description	Option	Modification Description
02	10.0A Current Coils	H	Dual Current Inputs
03	7.5A Current Coils	J	EXJ Register
04	2.5A Current Coils	L	Sliding Window Demand (Electronic LED Register)
05	1.0A Current Coils	M	Internal Modem Option (EXJ only)
06	480V Voltage Coils	P	Panel Mount (Semi-Flush)
07	240V Voltage Coils	R	Time Sync Input (Electronic LED Register)
08	60V Voltage Coils for 69V Systems	T	Time Pulse Output (Electronic LED Register)
09	Expanded Scale Volthours (90-150V)	U	Serial I/O Interface (ASCII) (Co-ed Register)
10	Register Ratio = 10:1 (Mechanical Register)	W	Waist Mount
11	Register Ratio = 100:1 (Mechanical Register)	Z	Additional Solid-State Output one function, must specify which
12	Register Ratio = 200:1 (Mechanical Register)	D D	Dual Demand (Electronic LED Register)
77	277V Voltage Coils	HC	High Count Rate
A	Polarity detect reversal blockout	MM	Mass Memory Option (EXJ only)
B	Surface Mount (Back Connection)	SW	Switchboard Case
C	Canadian (DCCA Approved)	Z Z	Additional Solid-State Output, two functions (not available on Volt functions or bi-directional Wh/VARh functions)
D	Demand (Only Available with E Option)		
E	Electronic Register		
F	Surface Mount (Front Connection)		

NOTE: L, R, and T options are not available on registers with U option, but are standard with EXJ. L option is not available on registers with DD option.

2 INSTALLATION

2.1. General

This section of the manual contains the data needed for grounding and mounting the meter. This section also contains meter dimensions and shows Input and Output connection data for most JEM1 meter models.

2.2. Grounding, Mounting And Dimensions

Figure 2-1 Grounding Direct Connected Units with Units with Front Connections (No Pts)

Figure 2-2 Grounding Direct Connected units with Rear Connections (No PTs)

Figure 2-3 Mounting and Dimensions Diagram for Flush (Panel) Mounting (P Option) JEM1 Meters

Figure 2-4 Surface (Wall) Mounting Diagram for (B Option) JEM1 Meters

Figure 2-5 Semi-Flush Panel Cutout, Waist Mount Bracket and Dimensions (W Option)

Figure 2-6 Outline & Dimensions for Panel Mounted ("P" Option) JEM 1 Meters

Figure 2-8 Mounting Dimensions for Front Connected (F Option) JEM1 Meters

2.3. Input Connections

Figure 2-9 Input Connections-Standard Models 3 Element, 3 Phase, 4 Wire

Figure 2-10 Input Connections-Standard Models 2-1/2 Element, 3 Phase, 4 Wire

Figure 2-11 Input Connections-Standard Models 2 Element, 3 Phase, 3 Wire

Figure 2-12 Input Connections-Standard Models 2 Element, **3** Phase, 3 Wire (Qh Meters only)

2.4. Grounding Instructions

STRICT ADHERENCE TO THE FOLLOWING GROUNDING RECOMMENDATION WILL INSURE OPTIMUM SURGE PROTECTION AND SAFETY.

1. Always ground the reference phase on installations using external potential transformers as shown in Figure 2-9, Figure 2-10, Figure 2-11, and Figure 2-2.

2. Always provide a separate ground to the case for all JEM1 Meters. The case ground terminal is available on output terminal #15 for rear connected meters and on a stud to the right of the inputs on front connected meters. The case ground should be terminated to the same ground point where the PT and CT grounds are terminated.

3. The use of two-element meters directly connected (with no Potential Transformers) to three-phase, three-wire systems will require the addition of an external varistor to protect against common mode voltage transients. Common mode transients are those which occur between any of the power line phases and ground. These type of installations should be connected as shown in Figure 2-11 and Figure 2-2, using the external Metal Oxide Varistor (MOV) from a Surge Arrestor Kit. If your meter uses instrument potential transformers, the external varistor will not be needed.

2.5. Surge Arrestor Kit For Direct Connected JEM1 Meters

Before connecting the varistor to a meter, check the voltage and Joule rating of the varistor. Table 2.1 lists the voltage rating required of the varistor. Connecting an improperly rated varistor could result in arcing or an explosion of the varistor.

Table 2-1 Surge Arrestor Color Codes & Voltage Ratings

Voltage	SCI Color & Rating	SCI P/N.
69 Volts	Yellow/95 Volt	11282-001K
120 Volts	Black/150 Volt	11282-002K
240 Volts	White/320 Volt	11282-003K
277 Volts	Blue/420 Volt	11282-004K
480 Volts	Red/575 Volt	11282-005K

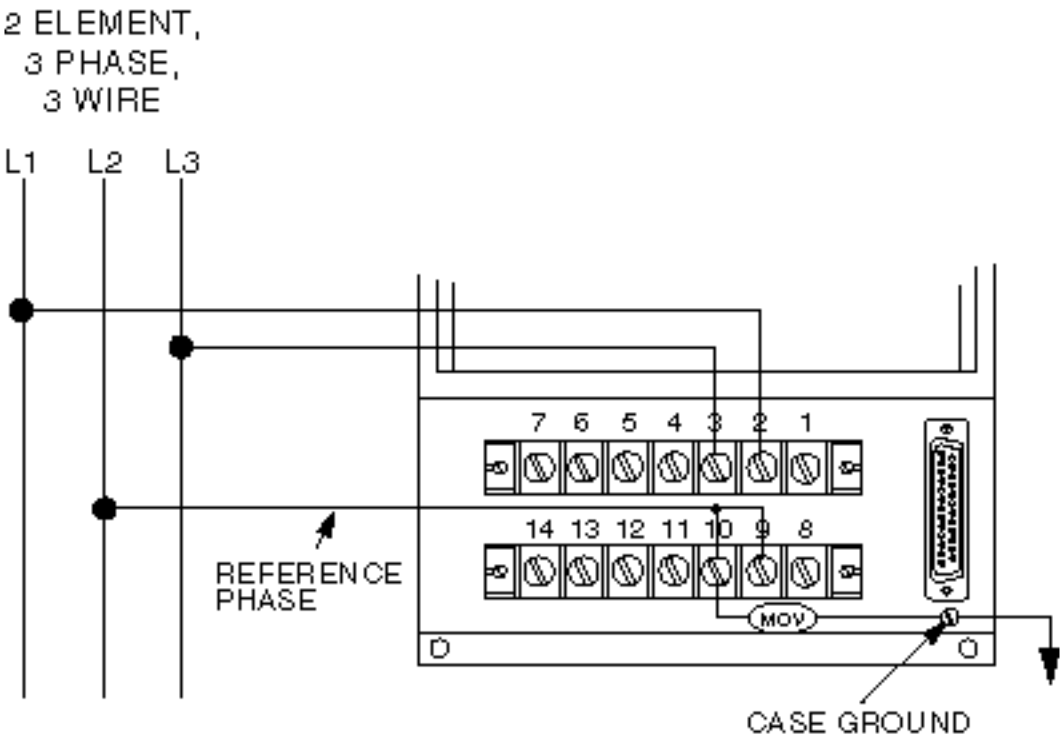


Figure 2-1 Grounding Direct Connected Units with Units with Front Connections (No Pts)

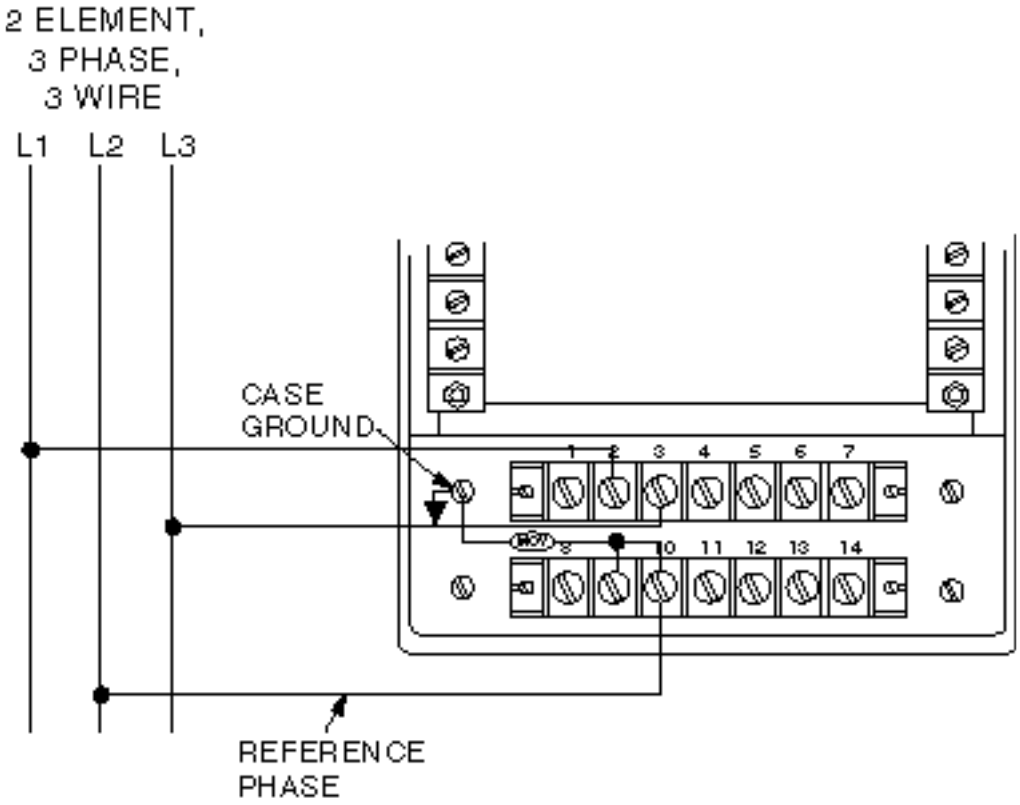


Figure 2-2 Grounding Direct Connected units with Rear Connections (No PTs)

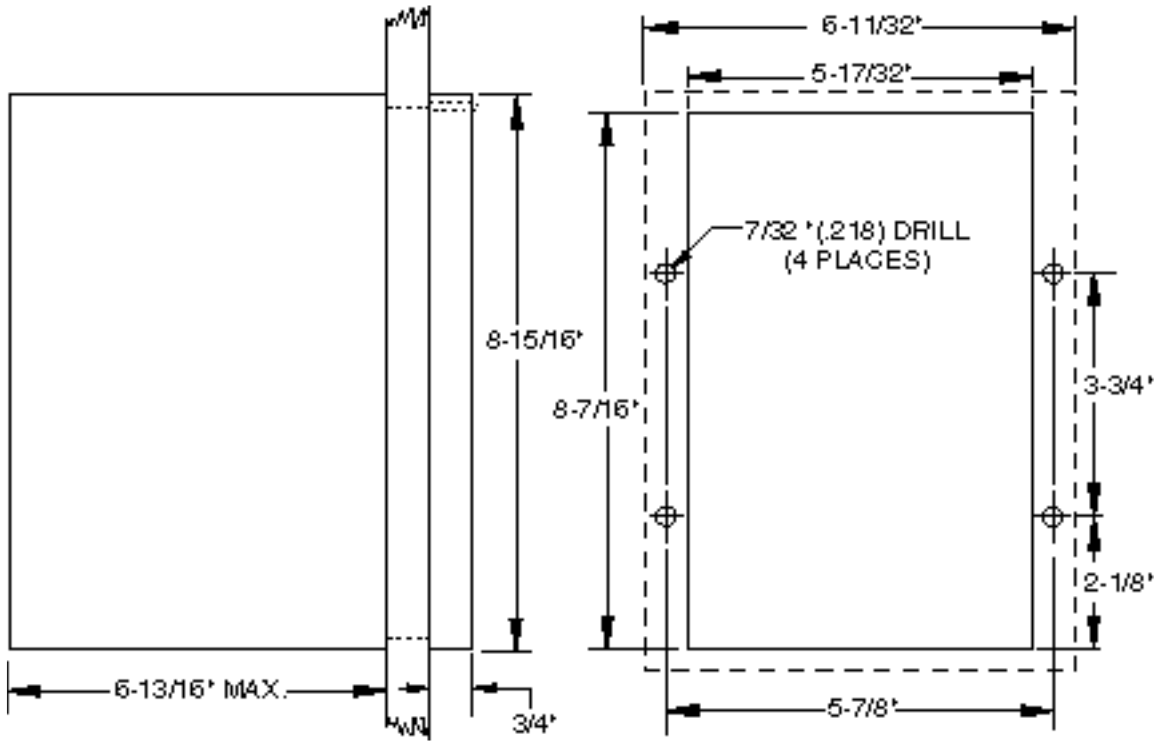


Figure 2-3 Mounting and Dimensions Diagram for Flush (Panel) Mounting (P Option) JEM1 Meters

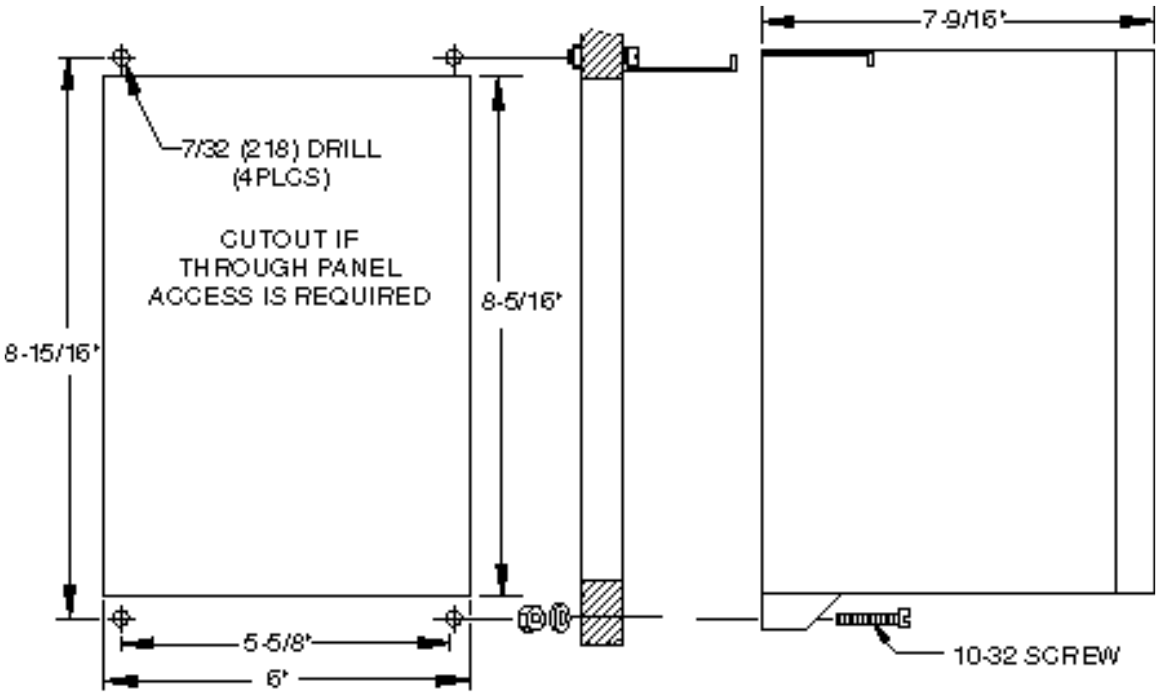


Figure 2-4 Surface (Wall) Mounting Diagram for (B Option) JEM1 Meters

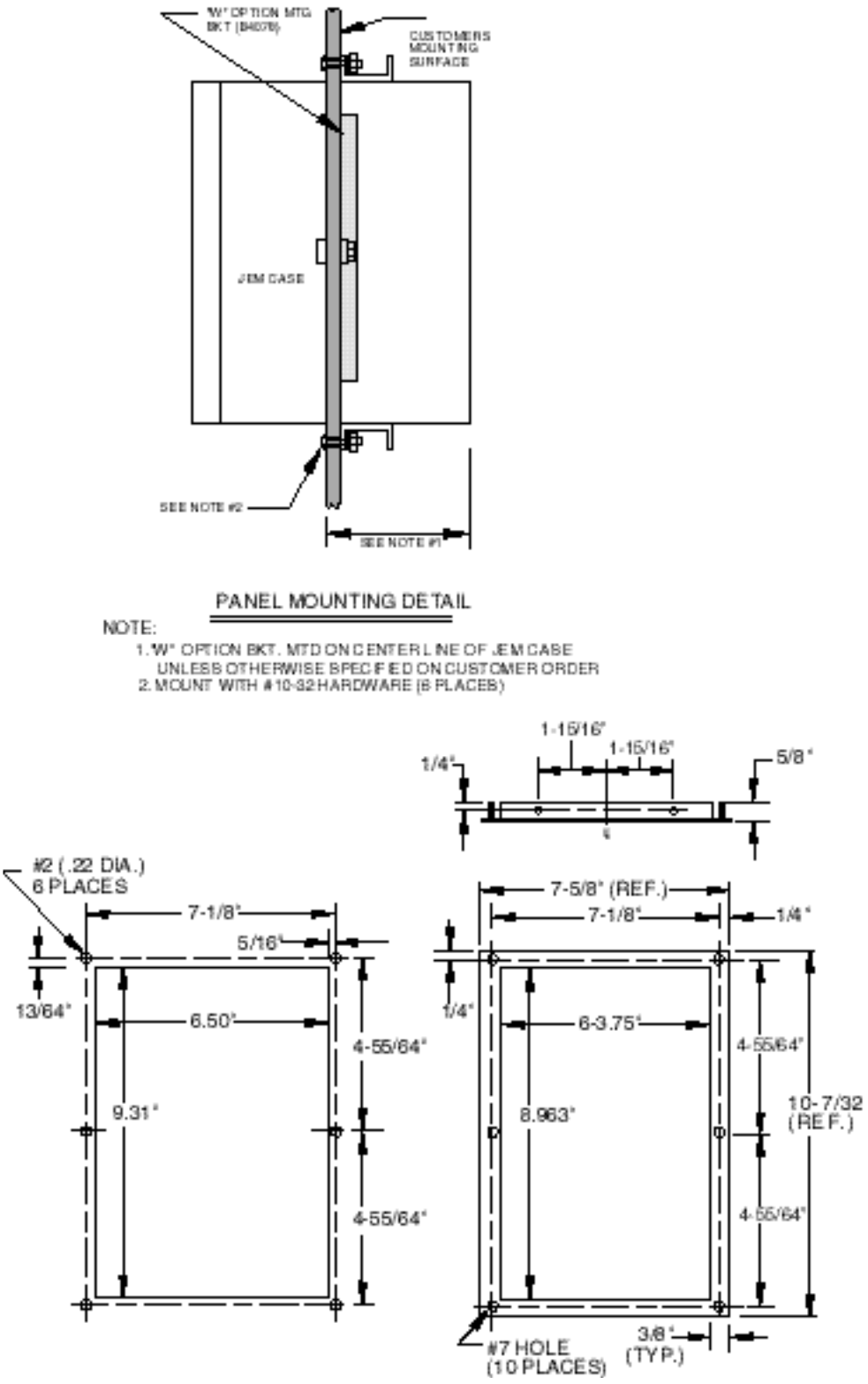


Figure 2-5 Semi-Flush Panel Cutout, Waist Mount Bracket and Dimensions (W Option)

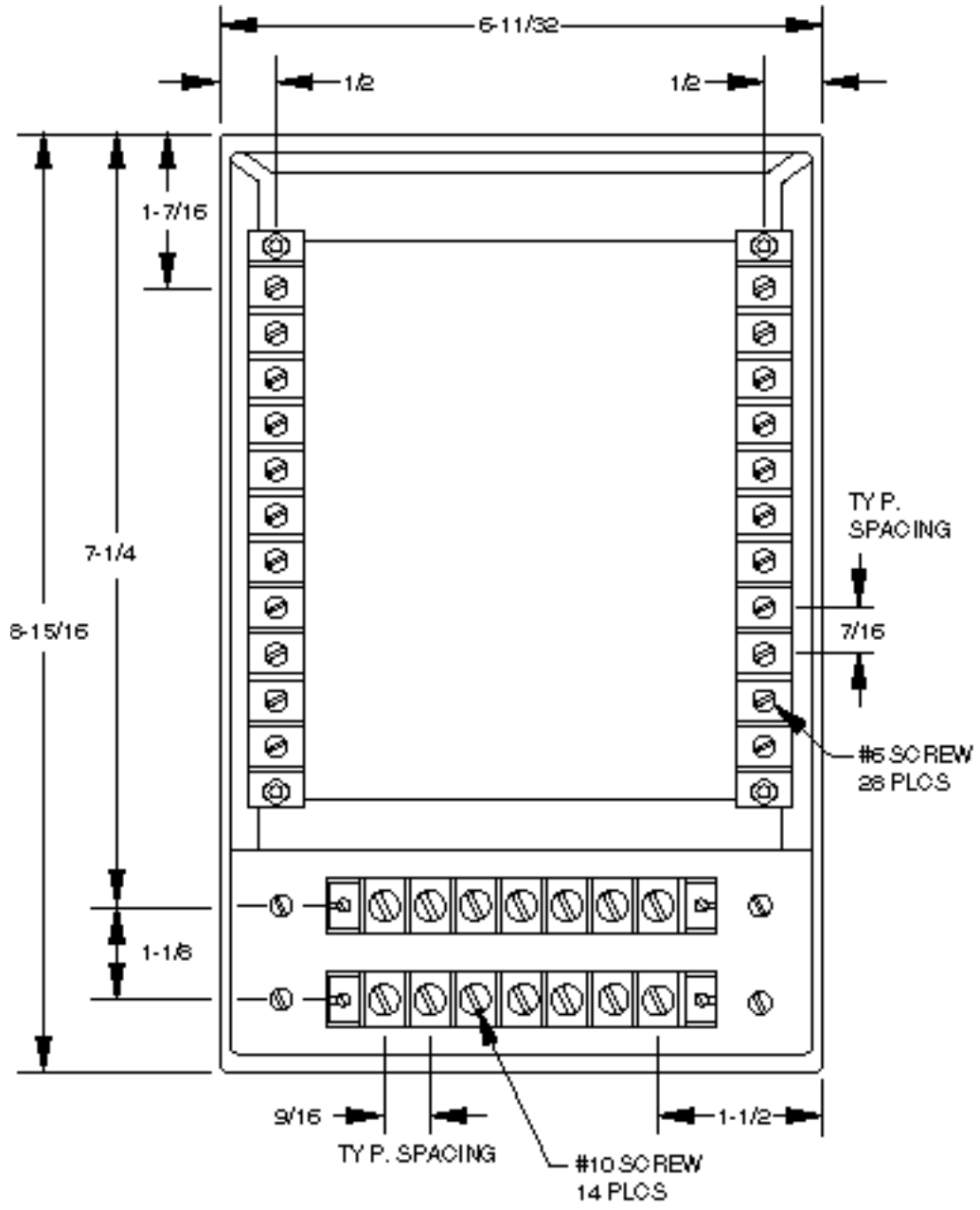


Figure 2-6 Outline & Dimensions for Panel Mounted ("P" Option) JEM 1 Meters

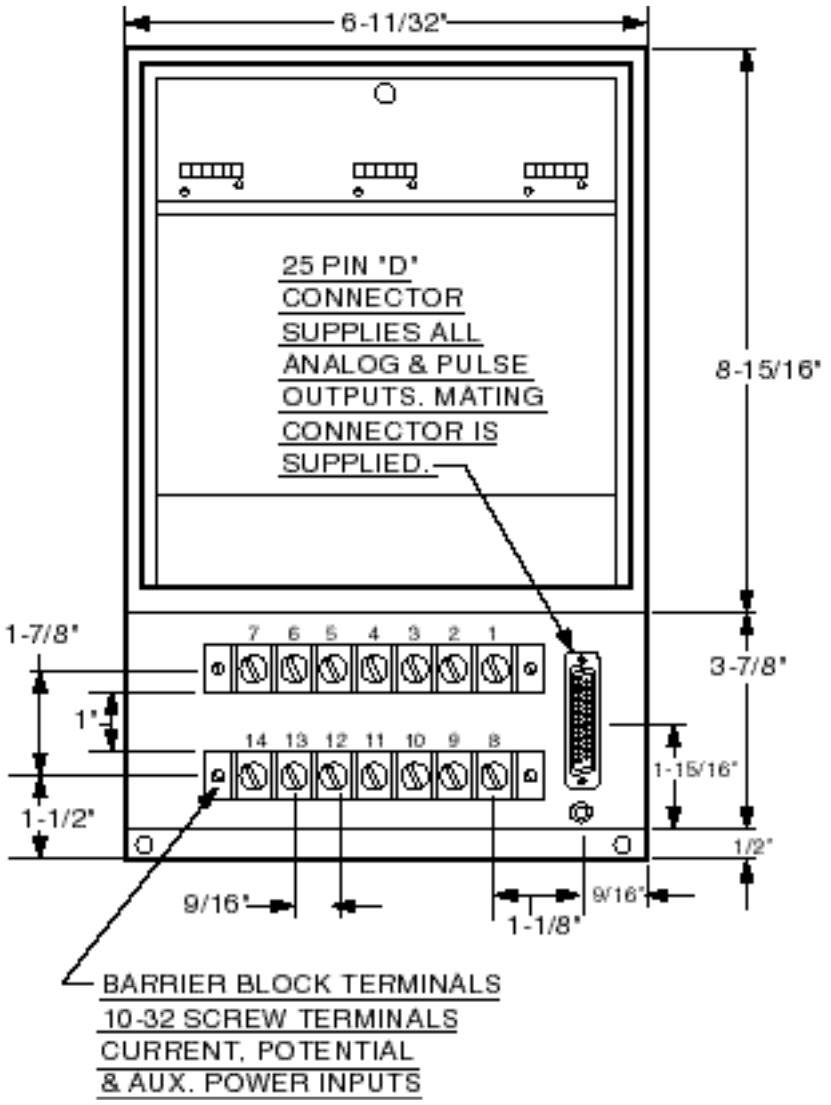


Figure 2-7 Outline and Dimensions for Front Connected (F Option) JEM1 Meters

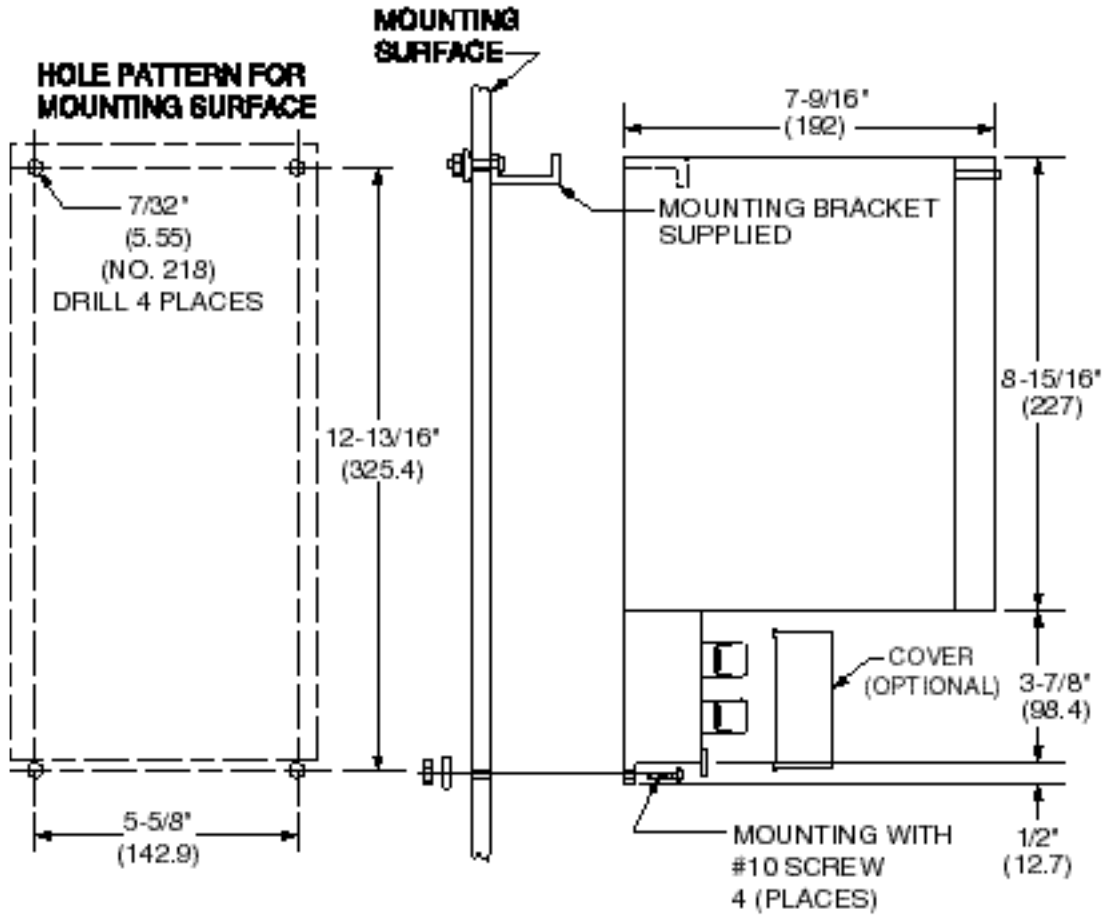


Figure 2-8 Mounting Dimensions for Front Connected (F Option) JEM1 Meters

(Mounting Bracket Part No. 03666-001)

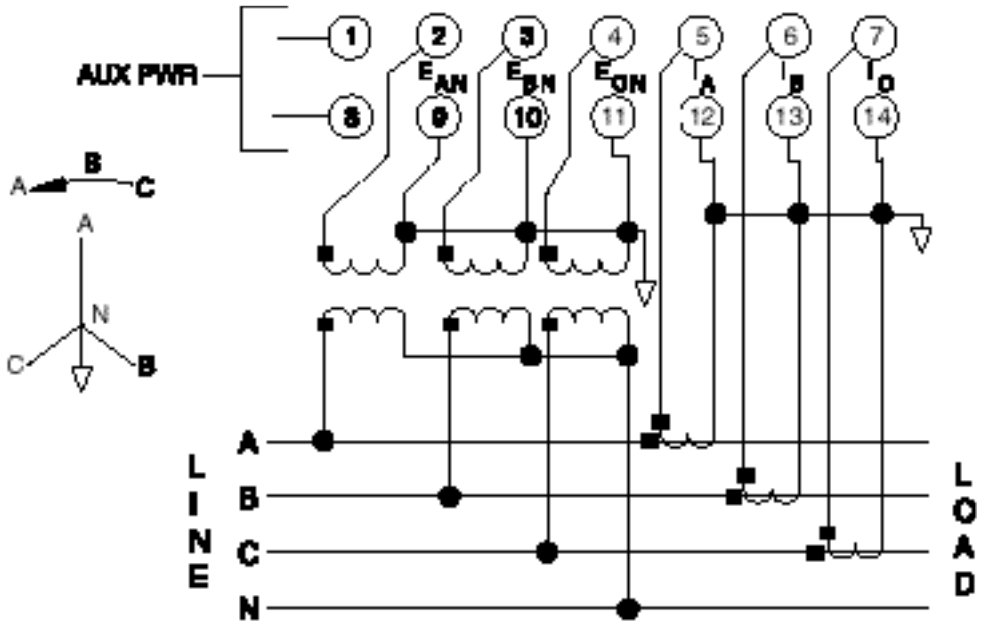


Figure 2-9 Input Connections-Standard Models 3 Element, 3 Phase, 4 Wire

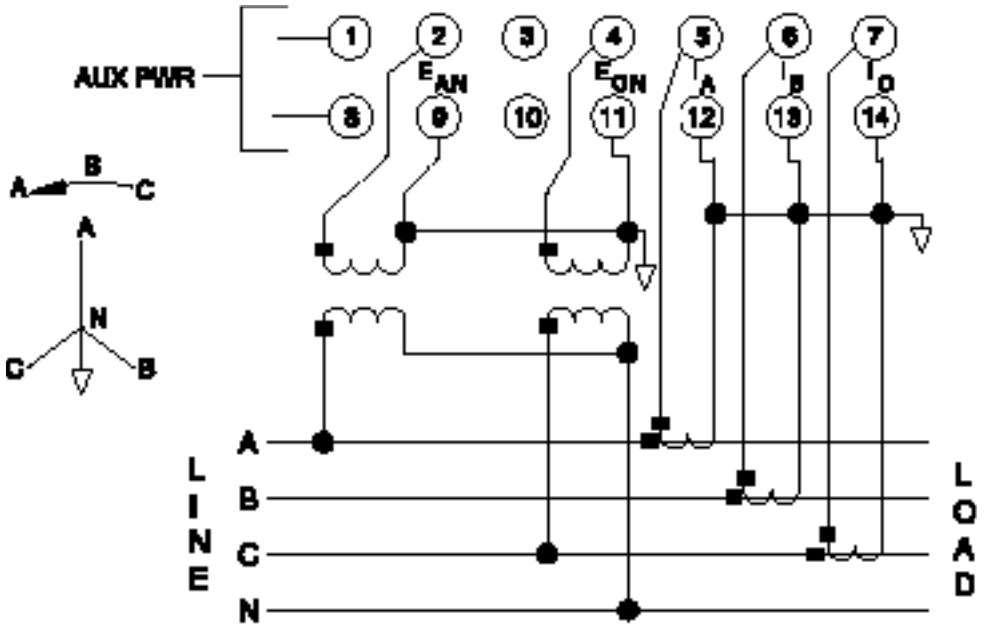


Figure 2-10 Input Connections-Standard Models 2-1/2 Element, 3 Phase, 4 Wire

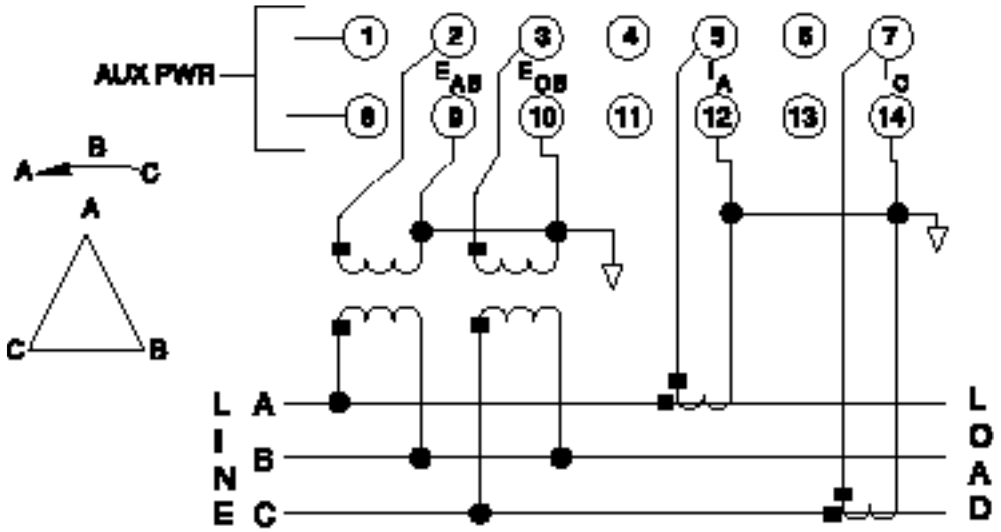


Figure 2-11 Input Connections-Standard Models 2 Element, 3 Phase, 3 Wire

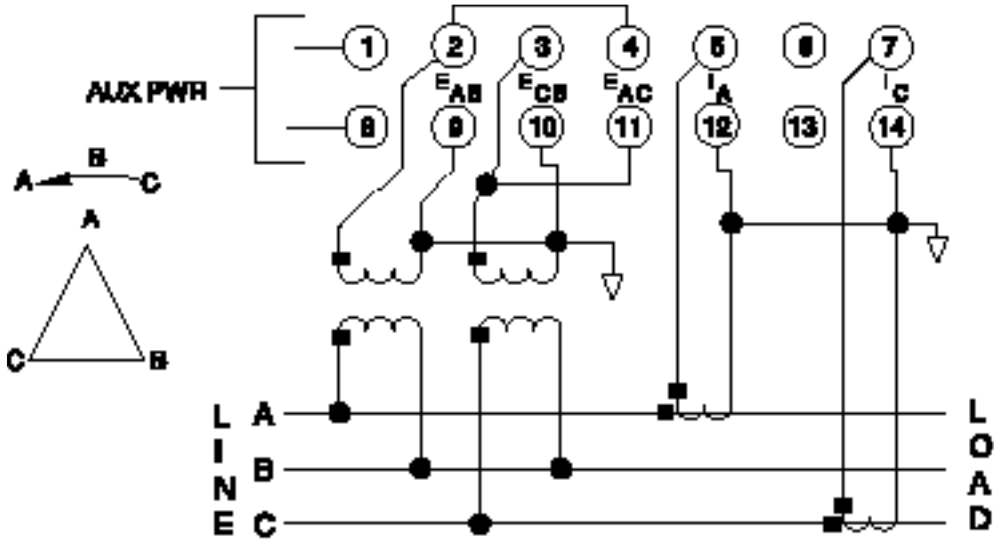


Figure 2-12 Input Connections-Standard Models 2 Element, 3 **Phase, 3 Wire (Qh Meters only)**

NOTES:

1. If A-C-B Phase rotation is used on meters with Q-hour function, connections to Lines B and C must be exchanged. * On all other non Q meter types, A-C-B Rotation does not affect meter connections.

2. Arrows "OUT" and "IN" show direction of energy flow for bi-directional meters.

3. Volt function meters respond to potential input applied to terminals 2 and 9 only. (Phase A Volts)

4. Auxiliary power ratings depend on the voltage rating of the meter. For example, if you have a -06, 480V meter then 480V auxiliary power is required. (In some cases 120V aux power is specified with a -06, 480V meter. This would then require auxiliary power of 120V while having a potential input of 480V nominal and is labeled on meter.)

5. On 69V rated meters, 120V auxiliary power is required and analog output is rated for 1.2mA @ 900 Watts.

2.6. Output Connections

There are many JEM1 model types with varying connections. Look up your model type in Table 2.2 and refer to the proper terminal numbers (B, P, F or SW option) for your JEM1. This table shows what your model type has for outputs and where they are located.

Figure 2-13 Rear Output Terminal Connections Panel Mount JEM1

Figure 2-1414 F & SW Option Output Terminal Connections

Table 2-1 Table for Output Signal Connections

* Please note that although different JEM1 model types have different outputs, most have watt/watthour as the primary function. Typically, the watt analog output is available on IO_1 and the watt pulse output is on KYZ_1. For bi-directional JEM1 Meters the analog output(s) are bi-polar while delivered pulses are output on KYZ_1 and received pulses are output on KYZ_2. For JEM1 Meters with a secondary function (VARS, Q etc.), the analog is available on IO_2 and pulses are on KYZ_3 and KYZ_4. Volt function JEM1 Meters always have Volt function analog available on output IO_3 and Volthour function JEM1 Meters have pulses on KYZ_5.

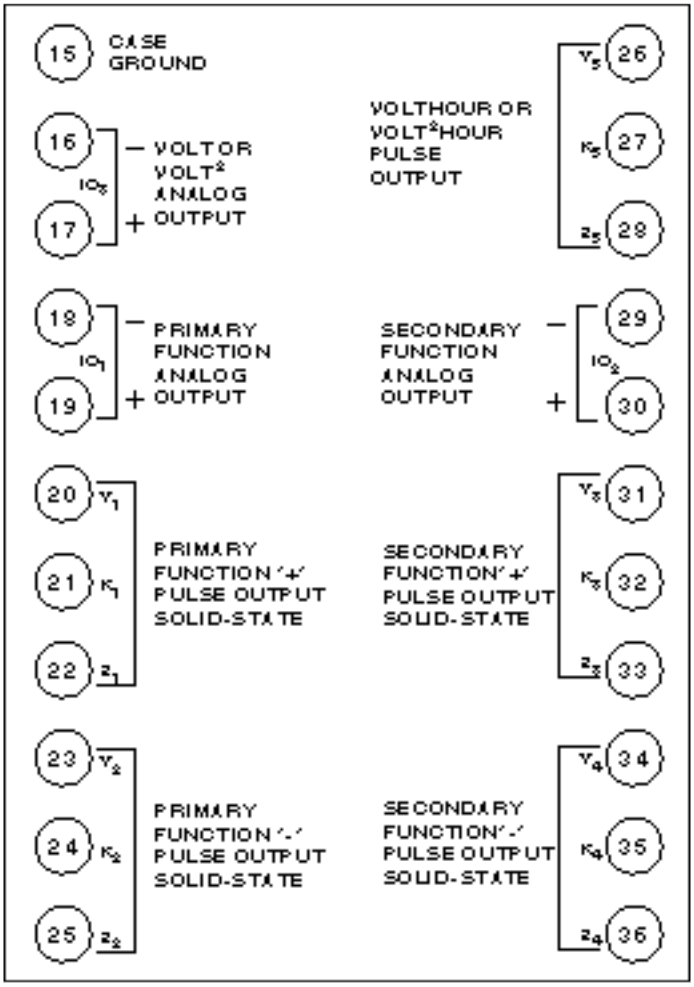


Figure 2-13 Rear Output Terminal Connections Panel Mount (B & P Option) JEM1

Note: Functions available depend on the model type of the JEM1. See Table 2.2 for functions available for your model type.

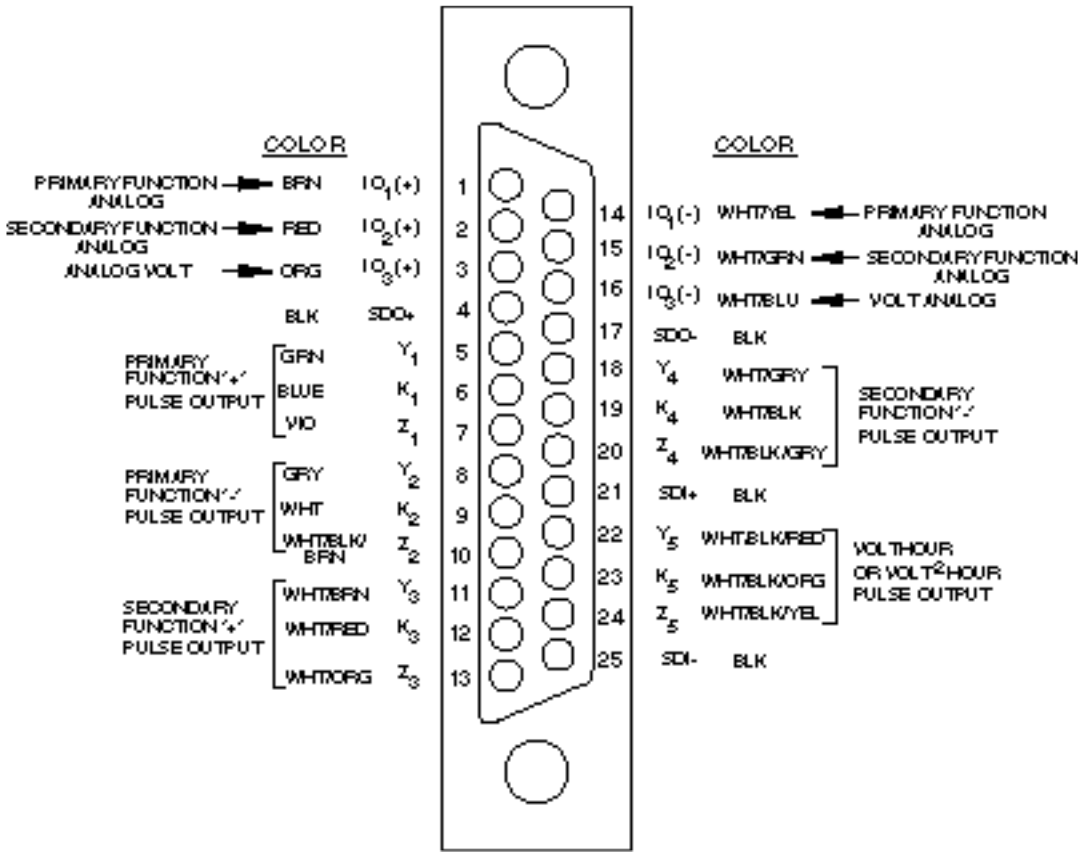


Figure 2-14 F & SW Option Output Terminal Connections

***NOTE:** For Switchboard type JEM1, Meter pins 4, 17, 21 and 25 are case ground.

Table 2-1 Table of Output Signal Connections

Terminal Numbers B or P Option F or SW Option	Analog Outputs			Pulse Outputs				
	IO_1 19(+), 18(-) 1(+), 14(-)	IO_2 30(+), 29(-) 2(+), 15(-)	IO_3 17(+), 16(-) 3(+), 16(-)	YKZ_1 20-21-22 5- 6- 7	YKZ_2 23-24-25 8- 9-10	YKZ_3 31-32-33 11-12-13	YKZ_4 34-35-36 18-19-20	YKZ_5 26-27-28 22-23-24
Models								
102/103/104	Watt	--	--	Watthour		--	--	--
112/113/114	Var	--	--	Varhour	--	--	--	--
121/121-09	--	--	Volt	--	--	--	--	Volthour
131/132/133	Ampere	--	--	Amphour	--	--	--	--
141/142/143	Ampere	--	--	--	--	--	--	--
152/153/154	Volt Amp	--	--	VA-hour	--	--	--	--
161/162/163	$Ampere^2$			Amp^2hour	--	--	--	--
202/203/204	Watt	--	--	"Out" Watthour	"In" Watthour	--	--	--
212/213/214	Var	--	--	"Lag" Varhour	"Lead" Varhour	--	--	--
302/303/304	Watt	Q		Watthour	--	Q-hour	--	--
312/313/314	Watt	Var	--	Watthour	--	Varhour	--	--
322/323/324	Watt	Var	--	"Out" Watthour	"In" Watthour	--	--	--
332/333/334	Watt	Var	--		--	--	--	--
342/343/344	Watt	Var	--	Watthour	--	--	--	--
352/353/354	Watt	VA	--	Watthour	--	VA-hour	--	--
362/363/364	Watt	Var	--	Watthour	--	Varhour	--	--
372/373/374	VA	Q	--	VA-hour	--	Q-hour	--	--
382/383/384	Watt	--	$(Volt)^2$	"Out" Watthour	"In" Watthour	--	--	V^2hour
392/393/394	Watt	Amp	--	Watthour	--	Amphour	--	--
402/403/404	Watt	--	Volt	Watthour	--	--	--	--
412/413/414	Watt	--	Volt	"Out" Watthour	"In" Watthour	--	--	--
422/423/424	Watt	Amp	--	Watthour	--	--	--	--
432/433/434	Watt	Amp	--	"Out" Watthour	"In" Watthour	--	--	--
442/443/444	Watt	Var	Volt	Watthour	--	--	--	--
452/453/454	Watt	Var	Volt	"Out" Watthour	"In" Watthour	--	--	--
462/463/464	Watt	Amp	Volt	Watthour	--	--	--	--
472/473/474	Watt	Amp	Volt	"Out" Watthour	"In" Watthour	--	--	--
482/483/484	Watt	VA	--	Watthour	--	--	--	--
492/493/494	Watt	Var	Volt	Watthour		Varhour		--
512/513/514	Watt	Q	$Volt^2$	Watthour	--	Q-hour	--	V^2hour
522/523/524	Watt	Var	$Volt^2$	Watthour	--	Varhour	--	V^2hour
532/533/534	Watt	VA	Volt	Watthour	--	VAhour	--	V-hour
542/543/544	Watt	Var	Volt	Watthour	--	Varhour	--	V-hour
552/553/554	Watt	Var	Volt	Watthour		Varhour		
562/563/564	Watt	I2	$Volt^2$	"Out" Watthour	"In" Watthour			
572/573/574	Var	I^2	$Volt^2$	"Lag" Varhour	"Lead" Varhour			
582/583/584	Watt	I^2	$Volt^2$	Watthour		I^2Hour		V^2hour
592/593/594	Watt	Var		"Out" Watthour	"In" Watthour	"Quad" Varhour	"Quad" Varhour	
602/603/604	Watt	Var		"Out" Watthour	"In" Watthour	"Lag" Varhour	"Lead" Varhour	--

Terminal Numbers B or P Option F or SW Option	Analog Outputs			Pulse Outputs				
	$IO1_1$ 19(+), 18(-) 1(+), 14(-)	$IO2_2$ 30(+), 29(-) 2(+), 15(-)	$IO3_3$ 17(+), 16(-) 3(+), 16(-)	YKZ_1 20-21-22 5- 6- 7	YKZ_2 23-24-25 8- 9-10	YKZ_3 31-32-33 11-12-13	YKZ_4 34-35-36 18-19-20	YKZ_5 26-27-28 22-23-24
612/613/614	Watt	Q	--	"Out" Watthour	"In" Watthour	Q-hour	--	--
622/623/624	Watt	Var	--	Watthour	--	"Lag" Varhour	"Lead" Varhour	--
632/633/634	Watt	VA	--	"Out" Watthour	"In" Watthour	VAhour	--	--
642/643/644	Watt	Q	$Volt^2$	"Out" Watthour	"In" Watthour	Q-hour	--	V^2-hour
652/653/654	Watt	Var	Volt	Watthour	--	"Lag" Varhour	"Lead" Varhour	V-hour
662/663/664	Watt	Var	$Volt^2$	Watthour	--	"Lag" Varhour	"Lead" Varhour	V^2hour
682/683/684	Watt	Var	$Volt^2$	"Out" Watthour	"In" Watthour	Varhour		V2hour
692/693/694	Watt	Var		"Out" Watthour	"In" Watthour	Varhour		
702/703/704	Watt	Var	Volt	"Out" Watthour	"In" Watthour	"Lag" Varhour	"Lead" Varhour	V-hour
712/713/714.	Watt	VA	$Volt^2$	Watthour		VAhour		V2hour
Special Options Model Z	--	--	--	--	Addl. Output	--	--	--
Model Z Z	--	--	--	--	Addl. Output	--	Addl. Output	--

This table shows terminal connections for Electronic style COEDS and V1.56 EXJs on B, P and F Option Meters. Use the table to see which terminals your options occupy. See the EXJ Users Guide for Pinouts of models later than version 1.56.

Terminal Numbers EXJ V1.56, B or P Option	38(+)	37(-)	40(+)	39(-)
F Option	4(+)	17(-)	21(+)	25(-)
COED (U) Opt. & EXJ 20 mA	+ SDO -		+ SDI -	
EXJ RS232	DTR	TXD	RXD	GND
T Option (Time Sync Output)	TP_{Out} Open Collector			
R Option (Time Sync Input)			TPIn (20 mA)	

NOTE: Additional "Z" outputs available at YKZ_2 and/or YKZ_4 are associated with YKZ_1 and YKZ_3, respectively, on models not using YKZ_2 and YKZ_4 otherwise

3 SUBASSEMBLIES, ADJUSTMENTS, AND CALIBRATION

3.1. General

1. This section contains information concerning:
2. Location of subassemblies and color coding (Figure 3-1 and Figure 3-2).
3. Calibration components checking and changing.
4. Calibration tables for setting Ke ranges.
5. Location of test points and adjustments (3.5).
6. Calibration & test procedures using a MicroJoule.
7. Calibration & test procedures using an SC-10, SC-10V/20 or SC-30.

Refer to the JEM1 Maintenance Manual for troubleshooting guides, detailed board layouts, and schematics.

3.2. Location of Subassemblies

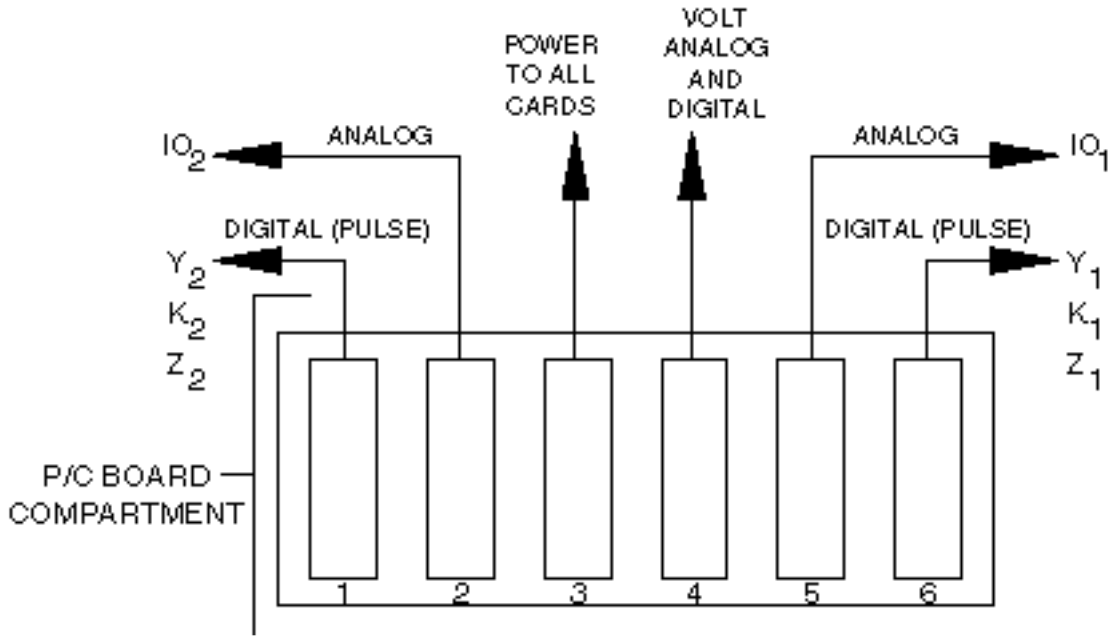


Figure 3-1 LOCATION AND FUNCTION OF PLUG-IN CARDS (SUB-ASSEMBLIES)

Card Position	Type	Function
1	Secondary Function Integrator Card	kVARh, kQh, kVAh, Ih (Pulse Output)
2	Secondary Function	kVAR, kQ, kVA, or Amp (Analog)
3	Power Supply/Oscillator	Power to all cards
4	Voltage Card	V/Vh, V^2/V^2h, or Expanded V/Vh (Analog and Pulse)
5	Primary Function (Analog)	kW (Analog)
6	Primary Function Integrator Card	kWh (Pulse Output)
7	Register Card	Display

3.3. Color Coding of JEM1 Subassemblies

Plug-In Subassembly	Color Dot	Card Position
Power Supply/Oscillator	Black	3
Watt/Q Multiplier, 2 & 2-1/2	Red	2/5
Watt/Q Multiplier, 3	Orange	2/5
Var Multiplier, 2 & 2-1/2	Yellow	2
Var Multiplier, 3	Gold	2
Integrator Unidirectional	Dark Blue	1/6
Integrator Bi-directional	White	1/6
VA Multiplier	Silver	2/5
Vh	Light Blue	4
Vh Expanded Scale	Green	4
V2h	Tan	4
Special Function Card	Coral	Any
Register Card	None	7

Color dots, approximately 1/4" diameter, are located on the side of the card ejector. A matching color dot is located on the meter card cage beside the appropriate subassembly slot. When a meter contains two of the same subassemblies, position will be indicated by location of color dot (left or right side).
Example: 504-09 kWh/Vh/kQh, 2-1/2 Element

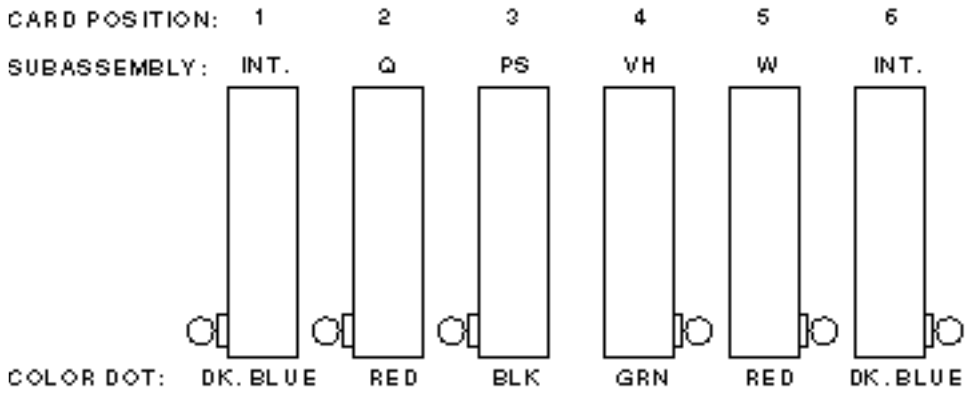


Figure 3-2 Color Coding of JEM1 Subassemblies

3.4. Calibration Checking and Changing

Ke values or pulse rate ranges are determined by selecting one of five resistor networks (A through E), and one of seven binary "divider taps" on the integrator boards. These components set the basic calibration range of the integrator potentiometer. There are different tables for different types of boards to be calibrated as well as tables for meters with different nominal inputs and meters with large Ke values.

1. Check the number of elements and nominal wattage of the unit and refer to the proper table (see Table List below). If a table does not exist for your nominal wattage refer to Table 3.10 for table adjustment.

2. Find the area on the table where your Ke falls. Look vertically to see which "Resistor Network" you will need (A, B, C, D, or E), and horizontally to see which Divider Tap to select (1 through 7) for your Ke. These components are located on the integrator board (Figure 3-3). Please note if your desired Ke is larger than shown on the standard tables, you will want to use the "special" calibration tables for slow pulse rate meters. In this case you will have a "Slow Mod" chip(s) in place of the standard 4040 chip(s) shown in Figure 3-3 on the integrator board(s).

3. The resistor network and tap selections set the basic range of the calibration adjustment potentiometer on the integrator board(s). A test against a standard will be needed to fine tune the cal potentiometer to a desired Ke (Figure 3-, adjustments, 6A & 1A).

Table Identification

Table 3-1 Calibration Table for 2 Element Watthour, Varhour, Qhour Meters

Table 3-2 Calibration Table for 2-1/2 and 3 Element Watthour, Varhour, Qhour Meters

Table 3-3 Special Calibration Table for 2 Element Slow Pulse Meters

Table 3-4 Special Calibration Table for 2-1/2 and 3 Element Slow Pulse Meters

Table 3-5 Calibration Table for 2400W, 2 Element Watthour, Varhour, and Qhour Meters

Table 3-6 Calibration Table for 3600W, 2-1/2 and 3 Element Watthour, Varhour, and Qhour Meters

Table 3-7 Calibration Table for Volthour Meters

Table 3-8 Calibration Table for $Volt^2hour$ Meters

Table 3-9 Calibration Table for Expanded Scale Volthour Meters

Table 3-10 Calibration Table Adjustment Chart

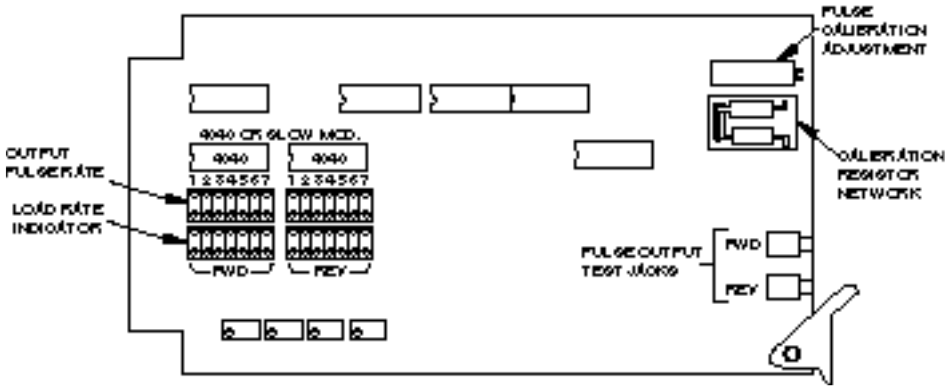


Figure 3-3 Integrator Calibration Component Location

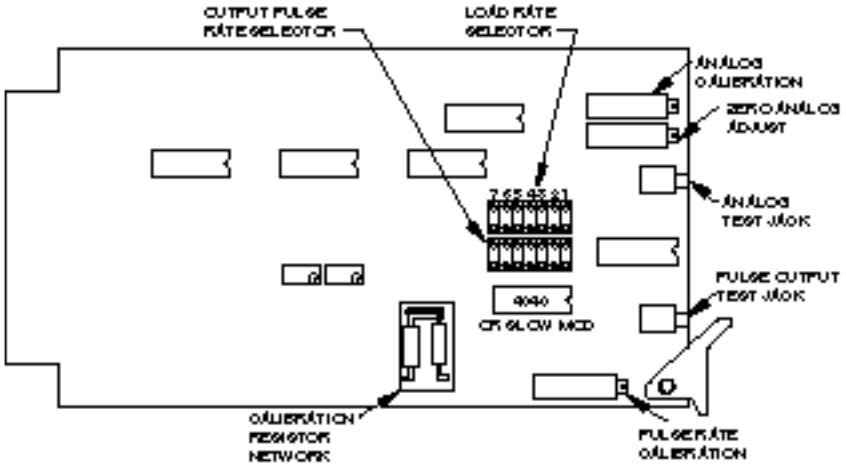


Figure 3-4 Volt, Volt2 and Expanded Scale Volt Calibration Component Location

Table 3-1 Calibration Table for 2 Element Watthour, Varhour, Qhour Meters

[Pulses/Hour at 1200W, Vars, or Qhour]
[Input (p/h) and Pulse constant (Ke)]
(Ke values shown are for 5A, 120V inputs only.)[2]

Divider Tap #								
1	p/h	206.4	246.0	288.0	330.0	372.0	412.8	
	Ke	**(5.81)	(4.87)	(4.17)	(3.64)	(3.23)	(2.91)	
2	p/h	412.8	492.0	576.0	660.0	744.0	825.6	
	K_e	(2.91)	(2.44)	(2.08)	(1.82)	(1.61)	(1.45)	
3	p/h	825.6	984.0	1152.0	1320.0	1488.0	1651.0	
	K_e	(1.45)	(1.22)	(1.04)	(0.909)	(0.806)	(0.726)	
4	p/h	1651.0	1968.0	2304.0	2640.0	2976.0	3302.0	
	K_e	(0.726)	(0.610)	(0.520)	(0.454)	(0.403)	(0.363)	
5	p/h	3302.0	3936.0	4608.0	5280.0	5952.0	6605.0	
	K_e	(0.363)	(0.305)	(0.260)	(0.227)	(0.201)	(0.181)	
6	p/h	6605.0	7872.0	9216.0	10560.0	11904.0	13210.0	*
	K_e	(0.181)	(0.152)	(0.130)	(0.113)	(0.101)	(0.091)	
7	p/h	13210.0	15744.0	18432.0	21120.0	23808.0	26419.0	
	K_e	(0.091)	(0.076)	(0.065)	(0.056)	(0.050)	(0.045)	
Calibration Network		» A º	» B º	» C º	» D º	» E º		

$$K_e = \frac{\text{Nominal Input}}{\text{Pulses/Hour}}$$

*Mechanical Register Count Speed Limitations

**For Ke values larger than 5.81 a slow mod chip (divide by 100) must be used in place of the 4040 shown in Figure 3.3. Use Table 3.3 for component selection.

[2] The counts per hour entries are valid for an input of 1.2mA from the analog card. The Ke will reflect the nomnal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-2 Calibration Table for 2-1/2 and 3 Element Watthour, Varhour, Qhour Meters

[Pulses/Hour at 1800W, Vars, or Qhour]
[Input (p/h) and Pulse constant (K_e)]
(K_e values shown are for 3 element @ 5A, 120V inputs only.)[3]

Divider Tap #							
1	p/h	206.4	246.0	288.0	330.0	372.0	412.8
	K_e	**(8.72)	(7.31)	(6.25)	(5.45)	(4.83)	(4.36)
2	p/h	412.8	492.0	576.0	660.0	744.0	825.6
	K_e	(4.36)	(3.65)	(3.12)	(2.73)	(2.419)	(2.180)
3	p/h	825.6	984.0	1152.0	1320.0	1488.0	1651.0
	K_e	(2.180)	(1.830)	(1.562)	(1.363)	(1.209)	(1.090)
4	p/h	1651.0	1968.0	2304.0	2640.0	2976.0	3302.0
	K_e	(1.090)	(0.915)	(0.781)	(0.681)	(0.604)	(0.545)
5	p/h	3302.0	3936.0	4608.0	5280.0	5952.0	6605.0
	K_e	(0.545)	(0.457)	(0.390)	(0.340)	(0.302)	(0.272)
6	p/h	6605.0	7872.0	9216.0	10560.0	11904.0	13210.0 *
	K_e	(0.272)	(0.229)	(0.195)	(0.170)	(0.151)	(0.136)
7	p/h	13210.0	15744.0	18432.0	21120.0	23808.0	26419.0
	K_e	(0.136)	(0.114)	(0.097)	(0.085)	(0.075)	(0.068)
Calibration Network		» A º	» B º	» C º	» D º	» E º	

$$K_e = \frac{\text{Nominal Input}}{\text{Pulses/Hour}}$$

*Mechanical Register Count Speed Limitation

**For Ke values larger than 8.72 a slow mod chip (divide by 100) must be used in place of the 4040 shown in Figure 3.3. Use Table 3.4 for component selection.

[3] The counts per hour entries are valid for an input of 1.2mA from the analog card. The Ke will reflect the nominal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-3 Special Calibration Table for 2 Element Slow Pulse Meters

[Pulses/Hour at 1200W, Vars, or Qhour]
[Input (p/h) and Pulse constant (K_e)]
(K_e values shown are for 5A, 120V inputs only.)[4]

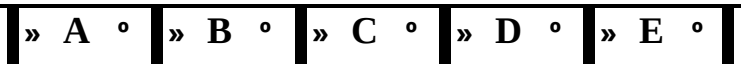
Divider Tap#							
1	p/h	2.064	2.460	2.880	3.30	3.720	4.128
	K_e	(581.39)	(487.80)	(416.66)	(363.63)	(322.58)	(290.69)
2	p/h	4.128	4.920	5.76	6.60	7.44	8.256
	K_e	(290.69)	(243.90)	(208.33)	(181.81)	(161.29)	(145.34)
3	p/h	8.256	9.84	11.52	13.20	14.88	16.51
	K_e	(145.34)	(121.95)	(104.16)	(90.90)	(80.64)	(72.68)
4	p/h	16.51	19.68	23.04	26.40	29.76	33.02
	K_e	(72.68)	(60.98)	(52.08)	(45.45)	(40.32)	(36.34)
5	p/h	33.02	39.36	46.08	52.80	59.52	66.05
	K_e	(36.34)	(30.49)	(26.04)	(22.72)	(20.16)	(18.16)
6	p/h	66.05	78.72	92.16	105.60	119.04	132.10
	K_e	(18.16)	(15.25)	(13.02)	(11.36)	(10.08)	(9.08)
7	p/h	132.10	157.44	184.32	211.20	238.08	264.19
	K_e	(9.08)	(7.62)	(6.51)	(5.68)	(5.04)	(4.54)
Calibration Network		» A º	» B º	» C º	» D º	» E º	

$$K_e = \frac{\text{Nominal Input}}{\text{Pulses/Hour}}$$

[4] The counts per hour entries are valid for an input of 1.2mA from the analog card. The Ke will reflect the nominal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-4 Special Calibration Table for 2-1/2 and 3 Element Slow Pulse Meters

[Pulses/Hour at 1800W, Vars, or Qhour]
Input (p/h) and Pulse constant (Ke)]
(Ke values shown are for 3 element @ 5A, 120V inputs only.)[5]

Divider Tap#							
1	p/h	2.064	2.460	2.880	3.300	3.720	4.128
	K_e	(872.09)	(731.70)	(625.00)	(545.45)	(483.87)	(436.04)
2	p/h	4.128	4.920	5.760	6.60	7.44	8.256
	K_e	(436.04)	(365.85)	(312.50)	(272.72)	(241.93)	(218.02)
3	p/h	8.256	9.720	11.52	13.20	14.88	16.51
	K_e	(218.02)	(185.18)	(156.25)	(136.36)	(120.96)	(109.02)
4	p/h	16.51	19.44	23.04	26.40	29.76	33.02
	K_e	(109.02)	(92.59)	(78.12)	(68.18)	(60.48)	(54.51)
5	p/hK	33.02	38.88	46.08	52.80	59.52	66.05
	e	(54.51)	(46.29)	(39.06)	(34.09)	(30.24)	(27.25)
6	p/h	66.05	77.76	92.16	105.60	119.04	132.10
	K_e	(27.25)	(23.14)	(19.53)	(17.04)	(15.12)	(13.62)
7	p/h	132.10	155.52	184.32	211.20	238.08	264.19
	K_e	(13.62)	(11.57)	(9.76)	(8.52)	(7.56)	(6.81)
Calibration Network							

$$K_e = \frac{\text{Nominal Input}}{\text{Pulses/Hour}}$$

[5] The counts per hour entries are valid for an input of 1.2mA from the analog card. The Ke will reflect the nominal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-5 Calibration Table for 2400W, 2 Element Watthour, Varhour, and Qhour Meters

[Pulses/Hour at 2400W, Vars, or Qhour]
[Input (p/h) and Pulse Constant (Ke)]
(Ke values shown are for 10A, 120V & 5A, 240V inputs only.)[6]

Divider Tap#							
1	p/h	206.4	246.0	288.0	330.0	372.0	412.8
	K_e	(11.62)	(9.74)	(8.34)	(7.28)	(6.46)	(5.82)
2	p/h	412.8	492.0	576.0	660.0	744.0	825.6
	K_e	(5.81)	(4.87)	(4.17)	(3.64)	(3.23)	(2.91)
3	p/h	825.6	984.0	1152.0	1320.0	1488.0	1651.0
	K_e	(2.91)	(2.44)	(2.08)	(1.82)	(1.61)	(1.45)
4	p/h	1651.0	1968.0	2304.0	2640.0	2976.0	3302.0
	K_e	(1.45)	(1.22)	(1.034)	(0.909)	(0.806)	(0.726)
5	p/h	3302.0	3936.0	4608.0	5280.0	5952.0	6605.0
	K_e	(0.726)	(0.610)	(0.520)	(0.454)	(0.403)	(0.363)
6	p/h	6605.0(	7872.0	9216.0	10560.0	11904.0	13210.0 *
	K_e	0.363)	(0.305)	(0.260)	(0.227)	(0.201)	(0.181
7	p/h	13210.0	15744.0	18432.0	21120.0	23808.0	26419.0
	K_e	(0.181)	(0.152)	(0.130)	(0.113)	(0.101)	(0.091)
Calibration Network		» A º	» B º	» C º	» D º	» E º	

$$K_e = \frac{\text{Nominal Input}}{\text{Pulses/Hour}}$$

Mechanical Register Count Speed Limitation

[6] The counts per hour entries are valid for an input of 1.2mA from the analog card. The Ke will reflect the nominal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-6 Calibration Table for 3600W, 2-1/2 and 3 Element Watthour, Varhour, and Qhour Meters

[Pulses/Hour at 3600W, Vars, or Qhour]
[Input (p/h) and Pulse Constant (Ke)]
(Ke values shown are for e element @ 10A, 120V & 5A, 240V inputs only.)[7]

Divider Tap#							
1	p/hK_e	206.4 (17.44)	246.0 (14.62)	288.0 (12.5)	330.0 (10.9)	372.0 (9.66)	412.8 (8.72)
2	p/hK_e	412.8 (8.72)	492.0 (7.31)	576.0 (6.25)	660.0 (5.45)	744.0 (4.83)	825.6 (4.36)
3	p/hK_e	825.6 (4.36)	984.0 (3.65)	1152.0 (3.12)	1320.0 (2.73)	1488.0 (2.419)	1651.0 (2.18)
4	p/hK_e	1651.0 (2.18)	1968.0 (1.83)	2304.0 (1.562)	2640.0 (1.363)	2976.0 (1.209)	3302.0 (1.09)
5	p/hK_e	3302.0 (1.09)	3936.0 (0.915)	4608.0 (0.781)	5280.0 (0.681)	5952.0 (0.604)	6605.0 (0.545)
6	p/hK_e	6605.0 (0.545)	7872.0 (0.457)	9216.0 (0.39)	10560.0 (0.34)	11904.0 (0.302)	13210.0 (0.272) *
7	p/hK_e	13210.0 (0.272)	15744.0 (0.229)	18432.0 (0.195)	21120.0 (0.170)	23808.0 (0.151)	26419.0 (0.136)
Calibration Network		» A º	» B º	» C º	» D º	» E º	

$$K_e = \frac{\text{Nominal Input}}{\text{Pulses/Hour}}$$

Mechanical Register Count Speed Limitation

[7] The counts per hour entries are valid for an input of 1.2mA from the analog card. The K_e will reflect the nominal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-7 Calibration Table for Volthour Meters

(K_e values 120V Input in Vh/Pulse.)[8]

Divider Tap #								
1	p/hK_e	206.4	246.0	288.0	330.0	372.0	412.8	
		(0.581)	(0.487)	(0.417)	(0.364)	(0.323)	(0.291)	
2	p/hK_e	412.8	492.0	576.0	660.0	744.0	825.6	
		(0.291)	(0.244)	(0.208)	(0.182)	(0.161)	(0.145)	
3	p/hK_e	825.6	984.0	1152.0	1320.0	1488.0	1651.0	
		(0.145)	(0.122)	(0.104)	(0.091)	(0.081)	(0.073)	
4	p/hK_e	1651.0	1968.0	2304.0	2640.0	2976.0	3302.0	
		(0.073)	(0.061)	(0.052)	(0.045)	(0.040)	(0.036)	
5	p/hK_e	3302.0	3936.0	4608.0	5280.0	5952.0	6605.0	
		(0.036)	(0.030)	(0.026)	(0.023)	(0.020)	(0.018)	
6	p/hK_e	6605.0	7872.0	9216.0	10560.0	11904.0	13210.0	*
		(0.018)	(0.015)	(0.013)	(0.011)	(0.010)	(0.009)	
7	p/hK_e	13210.0	15744.0	18432.0	21120.0	23808.0	26419.0	
		(0.009)	(0.0076)	(0.0065)	(0.0056)	(0.0050)	(0.0045)	
Calibration Network		» A º	» B º	» C º	» D º	» E º		

$$K_e = \frac{Vin}{Pulses/Hour} = \frac{120}{Pulses/Hour}$$

*Mechanical Register Count Speed Limitation

[8]The counts per hour entries are valid for an input of 1.2mA from the analog card. The K_e will reflect the nomnal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-8 Calibration Table for Volt^{2}hour Meters

(Ke values 120 V Input in V^2h/Pulse.)[9]

Divider Tap #							
1	p/h	206.4	246.0	288.0	330.0	372.0	412.8
	K_e	(69.7)	(58.5)	(50.0)	(43.6)	(38.7)	(34.9)
2	p/h	412.8	492.0	576.0	660.0	744.0	825.6
	K_e	(34.9)	(29.3)	(25.0)	(21.8)	(19.4)	(17.4)
3	p/h	825.6	984.0	1152.0	1320.0	1488.0	1651.0
	K_e	(17.4)	(14.6)	(12.5)	(10.9)	(9.68)	(8.72)
4	p/h	1651.0	1968.0	2304.0	2640.0	2976.0	3302.0
	K_e	(8.72)	(7.31)	(6.25)	(5.45)	(4.84)	(4.36)
5	p/h	3302.0	3936.0	4608.0	5280.0	5952.0	6605.0
	K_e	(4.36)	(3.66)	(3.13)	(2.73)	(2.42)	(2.18)
6	p/h	6605.0	7872.0	9216.0	10560	11904.0	13210.0 *
	K_e	(2.18)	(1.83)	(1.56)	0 (1.36)	(1.21)	(1.09)
7	p/h	13210.0	15744.0	18432.0	21120.0	23808.0	26419.0
	K_e	(1.09)	(0.0915)	(0.781)	(0.682)	(0.605)	(0.545)
Calibration Network		A	B	C	D	E	

$$K_e = \frac{14{,}400}{\text{Pulses/Hour}}$$

*Mechanical Register Count Speed Limitation

[9]The counts per hour entries are valid for an input of 1.2mA from the analog card. The K_e will reflect the nomnal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-9 Calibration Table for Expanded Scale Volthour Meters

[Pulses/Hour at 150 Volt Input]
K_e Values are for 90 to 150 Volt Input (60V Span)[10].

Divider Tap #								
1	p/h	165.1	196.8	230.4	264.0	297.6	330.25	
	K_e	(0.363)	(0.305)	(0.260)	(0.227)	(0.202)	(0.182)	
2	p/h	330.2	393.6	460.8	528.0	595.2	660.5	
	K_e	(0.182)	(0.152)	(0.130)	(0.114)	(0.101)	(0.0908)	
3	p/h	660.5	787.2	921.6	1056.0	1190.0	1321.0	
	K_e	(0.0908)	(0.0762)	(0.0651)	(0.0568)	(0.0504)	(0.0454)	
4	p/h	1321.0	1574.4	1843.0	2112.0	2381.0	2642.0	
	K_e	(0.0454)	(0.0381)	(0.0326)	(0.0284)	(0.0252)	(0.0227)	
5	p/h	2642.0	3148.8	3686.0	4224.0	4762.0	5284.0	
	K_e	(0.0227)	(0.0191)	(0.016)	(0.0142)	(0.0126)	(0.0114)	
6	p/h	5284.0	6297.6	7373.0	8448.0	9523.0	10568.0	*
	K_e	(0.0114)	(0.0095)	(0.0081)	(0.0071)	(0.0063)	(0.0057)	
7	p/h	10568.0	12595.2	14746.0	16896.0	19046.0	21135.0	
	K_e	(0.0057)	(0.0047)	(0.0041)	(0.0036)	(0.0032)	(0.0028)	
Calibration Network		A	B	C	D	E		

$$K_e = \frac{Vin - 90}{Pulses/Hour}$$

*Mechanical Register Count Speed Limitation

[10]The counts per hour entries are valid for an input of 1.2mA from the analog card. The K_e will reflect the nomnal voltage, current inputs, and number of elements (see Table 3.10)

Table 3-10 Calibration Table Adjustment Chart

For Table 3-1, Table 3-2, Table 3-3 and Table 3-4, Ke values shown are for 3 element and 2 element 5A and 120V inputs and 2 ½ @ 3.75 A 120V rated meters only. The chart below is used to adjust the Ke values in the tables for different voltage and/or current nominal ratings of meters. For example, in Table 3-2, all Ke values shown need to be multiplied by 0.5* if the current input is rated at 5A and the potential input is rated at 69V. This adjustment of Ke must be made to use the tables for setting cal resistor and divider tap settings on meters with ratings other than shown on the tables.

Range				
	Potential			
Current	69V	120V	240V	480V
1.0A	0.10	0.2	0.4	0.8
2.5A	0.25	0.5	1.0	2.0
5.0A	* 0.50	1.0 (REF)	2.0	4.0
7.5A	0.75	1.5	3.0	6.0
10.0A	1.0	2.0	4.0	8.0

3.5. Test Points and Adjustments

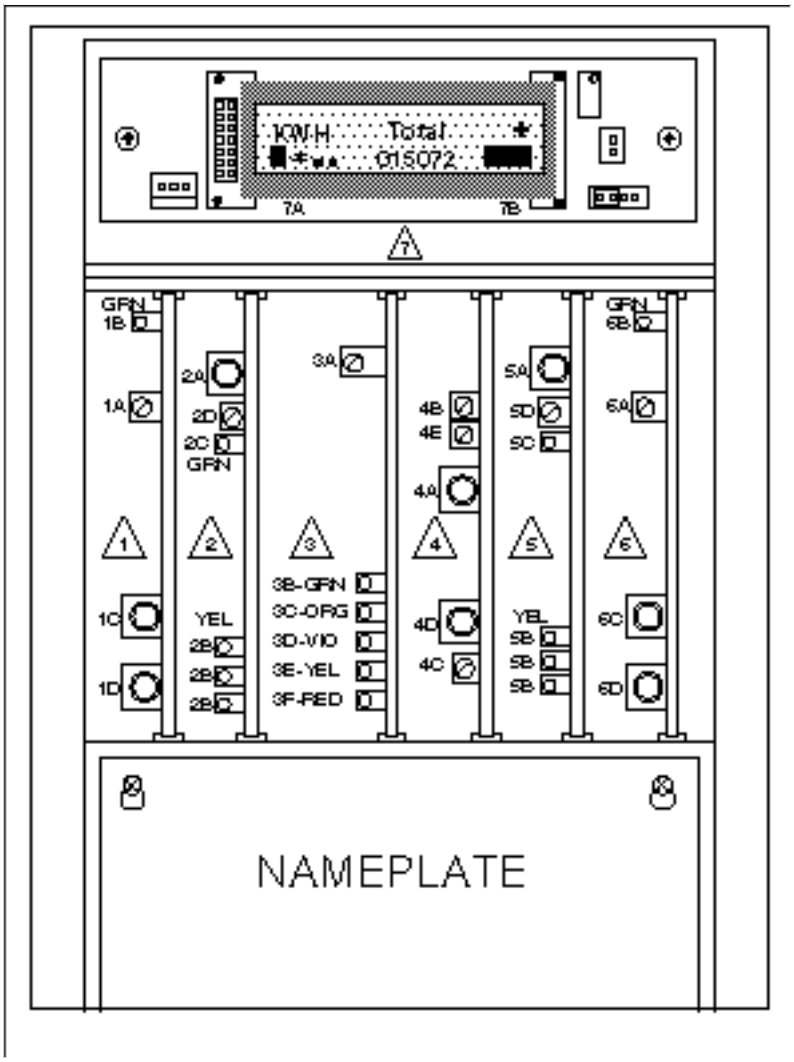
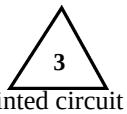


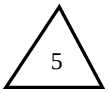
Figure 3-5 Test Points and Adjustments

3.5.1. Power Supply Assembly



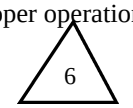
Provides supply voltages to all other printed circuit assemblies and contains a reference crystal oscillator used by the integrator boards. Adjustment - voltage reference (3A). Test points = +V is approximately +14.2 Vdc (3F Red), -V is approximately -14.2 Vdc (3C Orange), PS Common (3D Violet), V_{ref} = 5.8500 Vdc (3B Green), and oscillator 504 kHz (3E Yellow).

3.5.2. Primary Multiplier Assembly



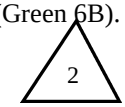
Converts input potential and current signals of primary function to dc analog signal. Adjustment - The analog calibration adjustment (5D) adjusts analog signal of the multiplier output. **NOTE**: The pulse rate of the associated integrator is also affected by adjustment (5D). Test points - The analog test jack, (5A), provides access to the output current signal. The jack is in series with the output provided at the rear barrier terminals. These terminals must be completed to obtain an output from the test jack. Test point - Chopped current input signals (Yellow 5B) and the triangle wave signal (Green 5C) can be viewed with an oscilloscope to verify proper operation of multiplier.

3.5.3. Primary Integrator Assembly



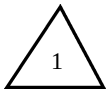
Converts an analog signal of primary function card to a pulse output (analog to digital). Adjustment - Fine tune pulse rate calibration (6A). Test pulse output, forward direction, open collector transistor. (6C). Test pulse output, reverse direction (6D), present on bi-directional function only. (Use Switchcraft Type 850 Microplug or equivalent for test plug.) Test point - Integration waveform - (Green 6B).

3.5.4. Secondary Multiplier Assembly



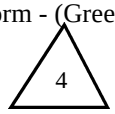
Second function multiplier. (Used for Var, Q, VA, or Amp.) Adjustments and test points same as Item 5.

3.5.5. Secondary Integrator Assembly



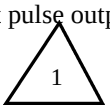
Second function integrator for dual function meters (Q-hour, Varhour, VA-hour or Amphour). Adjustment - Fine tune pulse rate calibration - (1A). Test pulse output forward direction, (1C). Test pulse output, reverse direction (1D), present on bi-directional function only. Test point - Integration waveform - (Green 1B).

3.5.6. Volt/Volthour or $Volt^2$/$Volt^2$hour Assembly



Monitors "A" potential input and generates analog and pulse signals. Adjustments - Analog calibration (4B), pulse rate calibration (4C), zero adjustment (4E). Test Points - Analog output jack (4A) and test pulse output jack (4D).

3.5.7. Register Assembly



Consists of one to four registers with associated circuits. Load rate indicators (7A) provided for each function show presence of load, toggling in sequence with the Form C output. Potential indicators (7B), provide presence indication of potential inputs. The register board counts pulses generated by the integrator boards for local display of consumption and demands. (See *EXJ Register* section for available features with EXJ JEM1 Meters.)

3.6. Calibrating the JEM1 with a Scientific Columbus MicroJoule Standard

The JEM1 can be tested with the MicroJoule by using the External Gate Test mode. In the External Gate mode, the microcomputer counts pulses fed into the external gate input and compares them to the simultaneously counted pulses from the internal SC-60 Standard. (See Figure 3.6 for a connection diagram.) Upon completion of a test, results are displayed immediately on the electronic readout.

When the microcomputer is in the External gate mode, the duration of the test is determined by the number of counts programmed into the N_t Register. High frequency standard pulses are recorded during the duration of the test and are accumulated in the N_S Register. N_t, Kh, and M values are preset and remain unaltered after an external gate test is complete. The test equation used by the MicroJoule is shown below:

$$\%R = \frac{Nt \times Kh}{Ns \times M \times \#\text{elements of unit}}$$

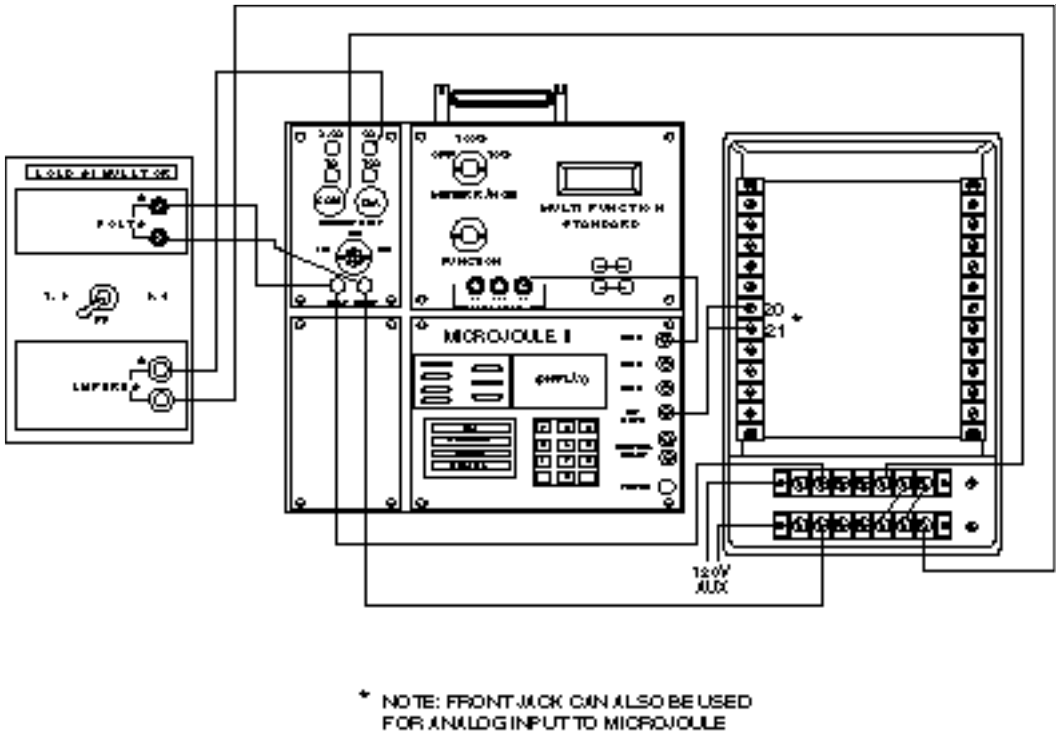


Figure 3-6 External Gate Test on a JEM1 Meter Using a Scientific Columbus Multifunction MicroJoule Standard

3.6.1. Testing Procedure Using the MicroJoule

a) Connections

Connect the MicroJoule and the JEM1 to a variable voltage, current, and power factor source. Select the proper voltage and current ranges on the MicroJoule. The voltage input of the MicroJoule is connected in parallel with the potential coils of the JEM1 and the current input should be connected in series with the current coils of the JEM1. (Individual elements may also be tested, observing proper test connections and constants.) See Figure 3.10 for connections and phasing relationships. Apply full scale voltage and current.

b) Analog Testing

If the analog transducer output is not to be tested proceed to step c. If the analog output of the JEM1 is to be tested, analog connections will need to be made. If your MicroJoule is a Model 6255, 6353 or 6253 with null meters, connect the analog output test jack, (5A) to the "TEST ANALOG INPUT" using the micro-plug cable provided with the MicroJoule. Apply a 1k ohm precision resistor across the "TEST ANALOG INPUT" for 2 or 3 element JEM1 Meters. (For 2-1/2 element JEM1 Meters use a 750 ohm precision resistor.) See Figure 3.7. The digital null meter on the MicroJoule now shows percent of full scale accuracy and fine tuning can be made by adjusting (5D) on the multiplier board. (If your MicroJoule does not have the "TEST ANALOG INPUT" with null meter then connect the null to an external volt/amp meter bucking the standard against the JEM1 output. Follow the same adjustment procedures as above.)

c) Pulse Testing

Connect the pulse output of the JEM1 to the "External Gate" input of the standard. The pulse output can be obtained from the front jack or from the KY or KZ output of the JEM1.

NOTE: JEM1 KYZ output connections vary. Refer to Table 2.2 of this manual for output connections of your JEM1 Model.

With power applied to the MicroJoule and the JEM1, the LED External Gate input indicator located on MicroJoule's front panel should be blinking. This indicates that the External Gate signal is being accepted. (If the indicator is not blinking, check polarity of the input to the External Gate connector or polarity of the JEM1 current inputs.)

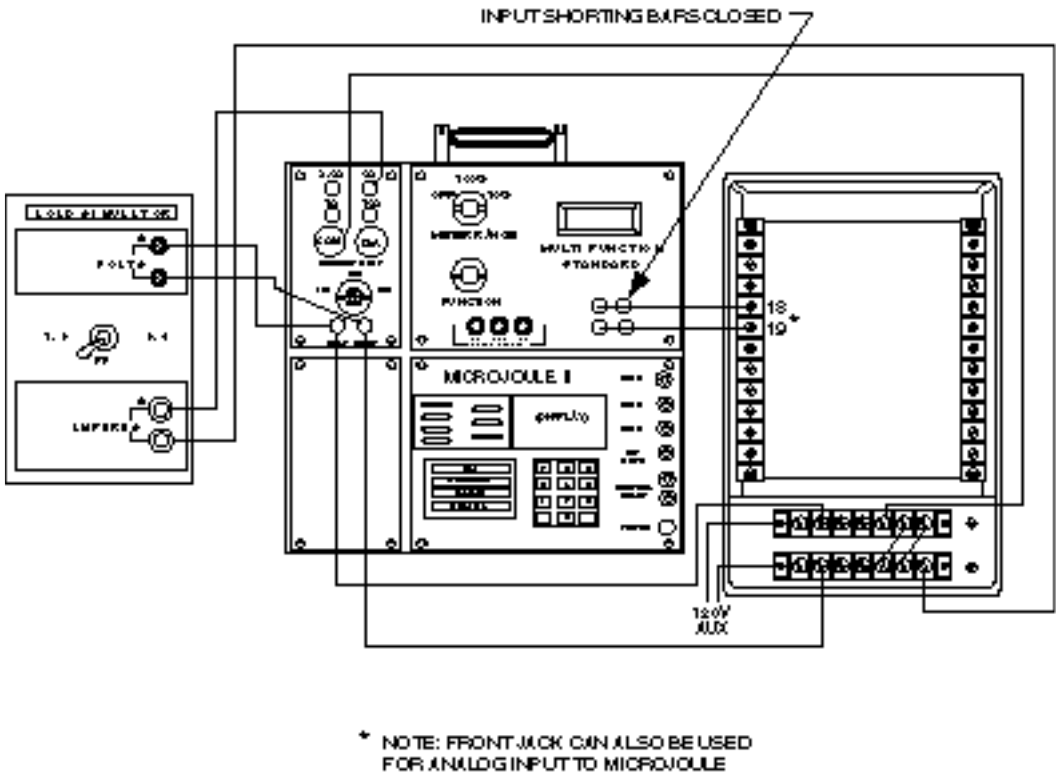


Figure 3-7 Multifunction MicroJoule Standard connections with input sorting bars closed

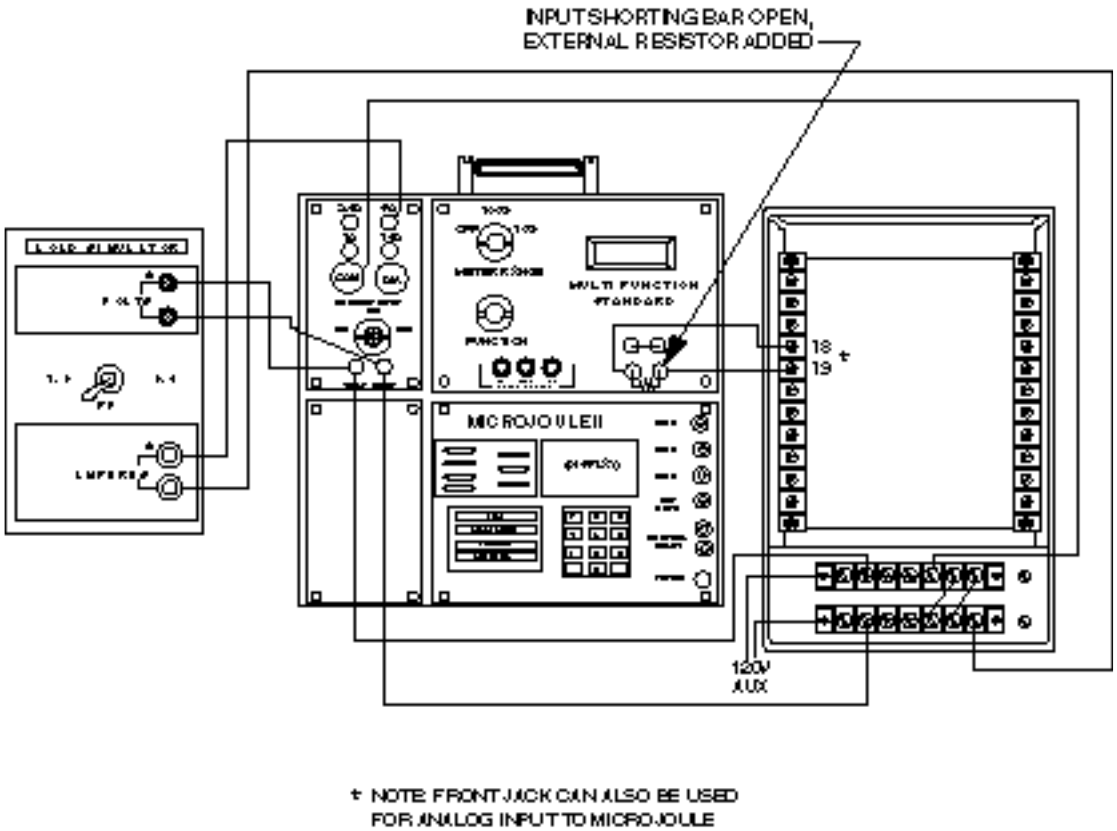


Figure 3-8 ANALOG NULL ON THE MULTIFUCTION MicroJoule STANDARD

d) Program the MicroJoule

Program the MicroJoule computer to run in External Gate mode. Select "TEST", then depress "External Gate". Select "Program" and enter Kh, *M Constant, N_t, # of elements, I_t, and V_t to match the JEM1's requirements and current and voltage taps used on the MicroJoule. Kh is set to two times the K_e marked on the meter and N_t is set to a number that allows for a minimum of 10,000 N_s pulses. (N_s is the number of standard pulses that accumulate for the duration of the test.) Smaller K_e values require larger N_t settings while larger K_e values require smaller N_t settings. A good rule of thumb is to set the N_t to a number that will allow for approximately a 30 second test duration at full load.

* M constant is set to .0006. See Tables 3.11 and 3.12 for M Constant values when testing Volt or Ampere function JEM1 Meters.

IMPORTANT NOTE!!

The programmed value of K_h in the MicroJoule must be twice the K_h (K_e) rating on the label of the JEM1. This is necessary because only one set of contacts (K-Y or K-Z) can be connected to the External Gate input and only every other pulse will be counted.

e) Initiate Pulse Test

Adjust the voltage, current and power factor to the desired test levels and then depress Test, then "Start Full Load". The display will indicate the number of gate pulses programmed into the N_t memory register and will begin to count down to zero as External Gate pulses are received from the meter.

f) Completion of Pulse Test

When the countdown to zero is complete, the 6-digit electronic readout will display the result of the %R calculation as well as the N_s (# of MicroJoule counts). The test may be repeated as many times as desired without additional programming. If an adjustment is needed, simply fine tune the integrator potentiometer (6A) until desired test results are achieved.

g) Different Levels of Voltage and Current

With the MicroJoule programmed as is, merely set the external power level to a new value by varying voltage, current, and/or power factor, as desired, and depress "Start Full Load" again. Re-programming is required only when changing the current or voltage ranges of the SC-60 Standard and/or the K_h or connections of the meter. There are no additional adjustments for light load and power factor.

h) Checking Additional Functions (If applicable)

Check other functions (Vars, Volts, etc.) in the same manner as above. Start on Step b, although make adjustments in the same order as the watt function except use the potentiometers that correspond to the function.
Qhour testing on the JEM1 Meters are tested with the watthour standard although test connections are different. (See Test Connection Diagrams, Figure 3.10.)

i) Check Register Operation

With load applied check all register functions for proper accumulation of pulses. This will assure for proper programming of registers.

Table 3-1 Values of M constant for Volthour, Volt^{2}hour, and Expanded Scale Volthour Tests

Nominal Voltage of JEM1	Volthour	Volt^{2}hour	Expanded Scale Volthour
120	0.00012	0.0144	0.00072 Multiply K_h by 10 *
240	0.00024	0.0576	0.00144 Multiply K_h by 10 *
480	0.00048	0.2304	0.00288 Multiply K_h by 10 *

*__Note__: Program the # of Elements to "1" for Volt testing

Table 3-2 Values of M Constant for Currenthour and Current^{2}hour Tests

Current Tap Used on MicroJoule	Amperehour	Ampere^{2}hour
1.0A	0.00001 Multiply K_h by 10 *	0.00001 Multiply K_h by 10 *
2.5A	0.00025 Multiply K_h by 100 *	0.00625 Multiply K_h by 1000*
5.0A	0.00005 Multiply K_h by 10 *	0.00025 Multiply K_h by 10*
7.5A (6255 Only)	0.00075 Multiply K_h by 100 *	0.05625 Multiply K_h by 1000 *
10.0A (6255 Only)	0.00001	0.00001
15.0A (6255A Only)	0.00015 Multiply K_h by 10 *	0.00225 Multiply K_h by 10 *
50.0A (6255A Only)	0.00005	0.0025

(*) The microcomputer readout of the MicroJoule is limited to six digits. To overcome this limitation, the decimal point has been moved in this table. For the microcomputer to calculate the correct %R, CF and %E, it is necessary to modify the meter constant of the device under test as listed in the table.

3.7. Calibrating the JEM1 with Scientific Columbus Field Standards

The JEM1 can be tested with the SC-10, SC-10V/20, or SC-30 field standards. The standard must be controlled by using a Test Pulse Adapter (preset counter) in either a potential interrupt mode or a gate control mode. JEM1 pulses are fed into the Test Pulse Adapter which starts and stops the field standard. A control relay in the Test Pulse Adapter is wired to control the voltage on the SC-10 or the gate input on the SC-30. Upon count down completion of a pre-determined amount of test pulses (N_t), the standard pulses are recorded and entered into the following formula:

$$\%R = \frac{N_t \times K_e}{N_s \times M \times \#\ \text{elements of unit}} \times 100$$

Where:

N_t = Number of pulses tested

K_e = K_e from meter label, (x2)

N_s = Standard pulses or reading from standard

M = Pulse constand of standard (0.6 for type SC-10. SC-10V/20 and 1.0 for SC-30)

\# = The number of elements of the meter (use 4 on $2\frac{1}{2}$ element meters)

3.7.1. Testing Procedure Using SC-10, SC-10V/20 or SC-30

a) Connections

Connect the JEM1 inputs as shown in the test connections. Connect the SC-10, SC-10V/20 as shown in Figure 3.8 andthe SC-30 as shown in Figure 3.9. As mentioned above, when using the SC-10 the control relay will be wired in series with the potential circuit instead of into the gate. Apply full scale watts.

b) Pulse Testing

Connect the pulse output of the JEM1 to the Test Pulse Adapter. The pulse output can be obtained from the front jack or from the KY or KZ output of the JEM1. (JEM1 KYZ output connections vary. Refer to Table 2.2 of this manual for output connections of your JEM1 model.) Set the Test Pulse Adapter (modify N_t) to count enough pulses which will allow for approximately a 30 second test. The smaller the N_t the shorter the test and larger the N_t the longer the test.

c) Initiate Pulse Test

Start a full load test. The field standard should increment from zero and stop after the last pulse is counted.

d) Completion of Pulse Test

When the test is complete the reading from the standard is entered into the % Registration formula for results. If an adjustment is needed, simply fine tune the integrator potentiometer (6A) until desired test results are achieved.

e) Different Levels of Voltage and Current

Test other levels of voltage and/or current as needed. Please note testing is the same as in full load testing and there are no additional adjustments for light load and power factor.

f) Checking Additional Functions (if applicable)

Vars can be tested if you are using an SC-20 or SC-30-RQ standard. The procedure is the same as testing the watthour function except select (Varhour) on the standard and set the Load Source for reactive power. The test pulse output is obtained from Test Jack 1C and adjustment is made at 1A. Qhour testing on JEM1 Meters are tested with the watthour standard although test connections are different. (See Test Connection Diagrams, Figure 3.10.)

g) Check Register Operation

With load applied check all register functions for proper accumulation of pulses. This will assure for proper programming of registers.

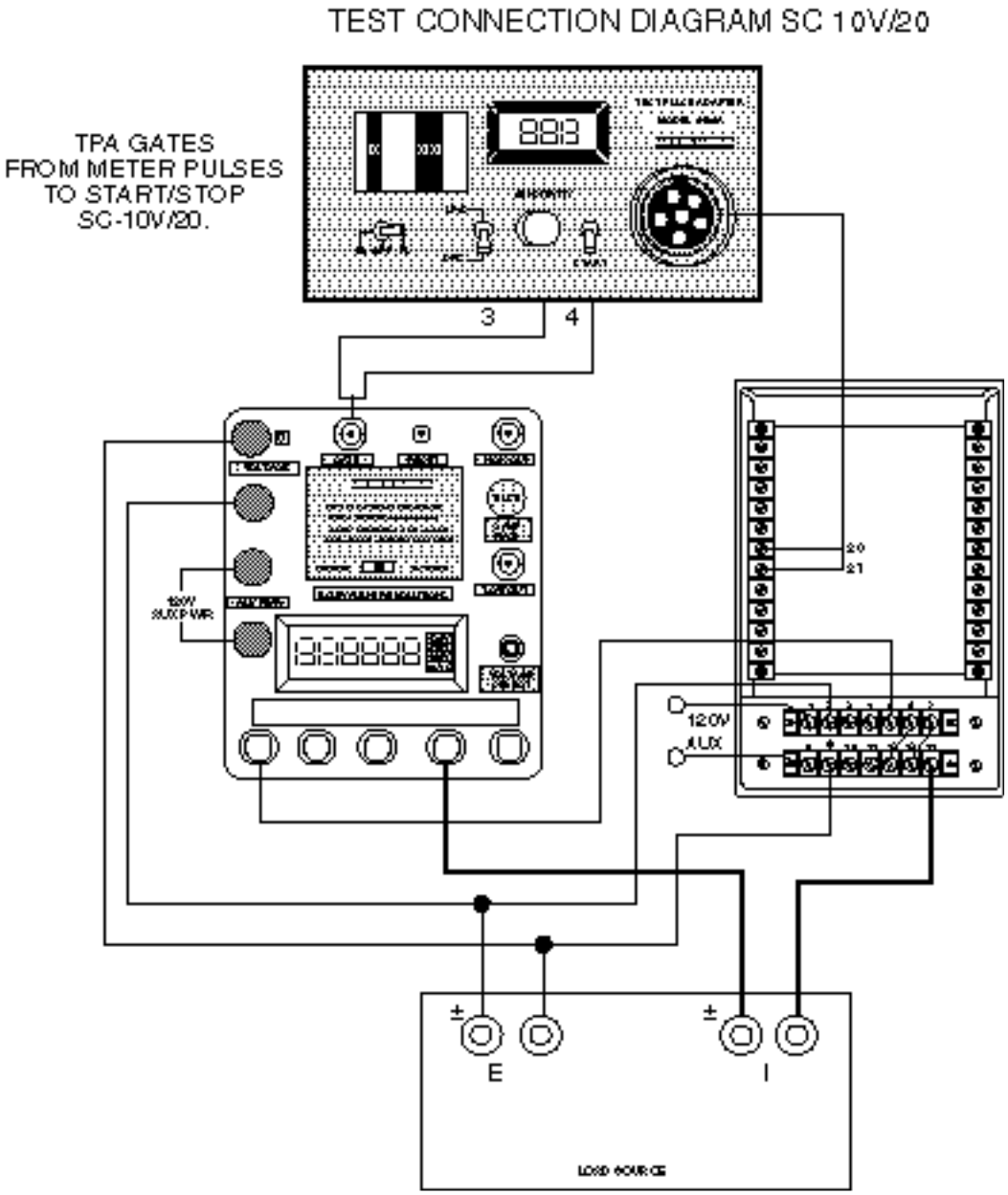


Figure 3-9 TEST CONNECTION DIAGRAM SC-10V/20

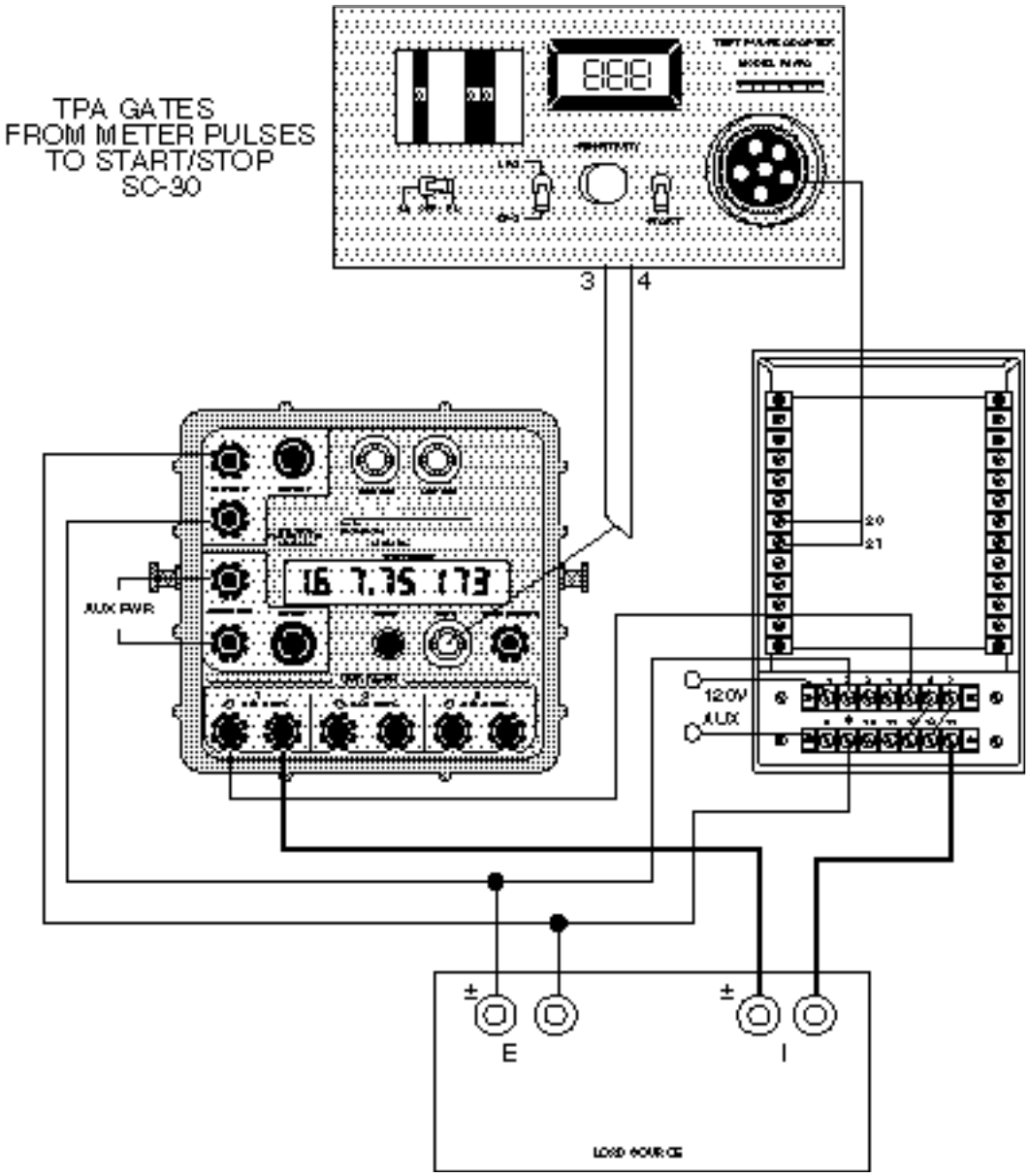


Figure 3-10 Test Connection Diagram SC-30

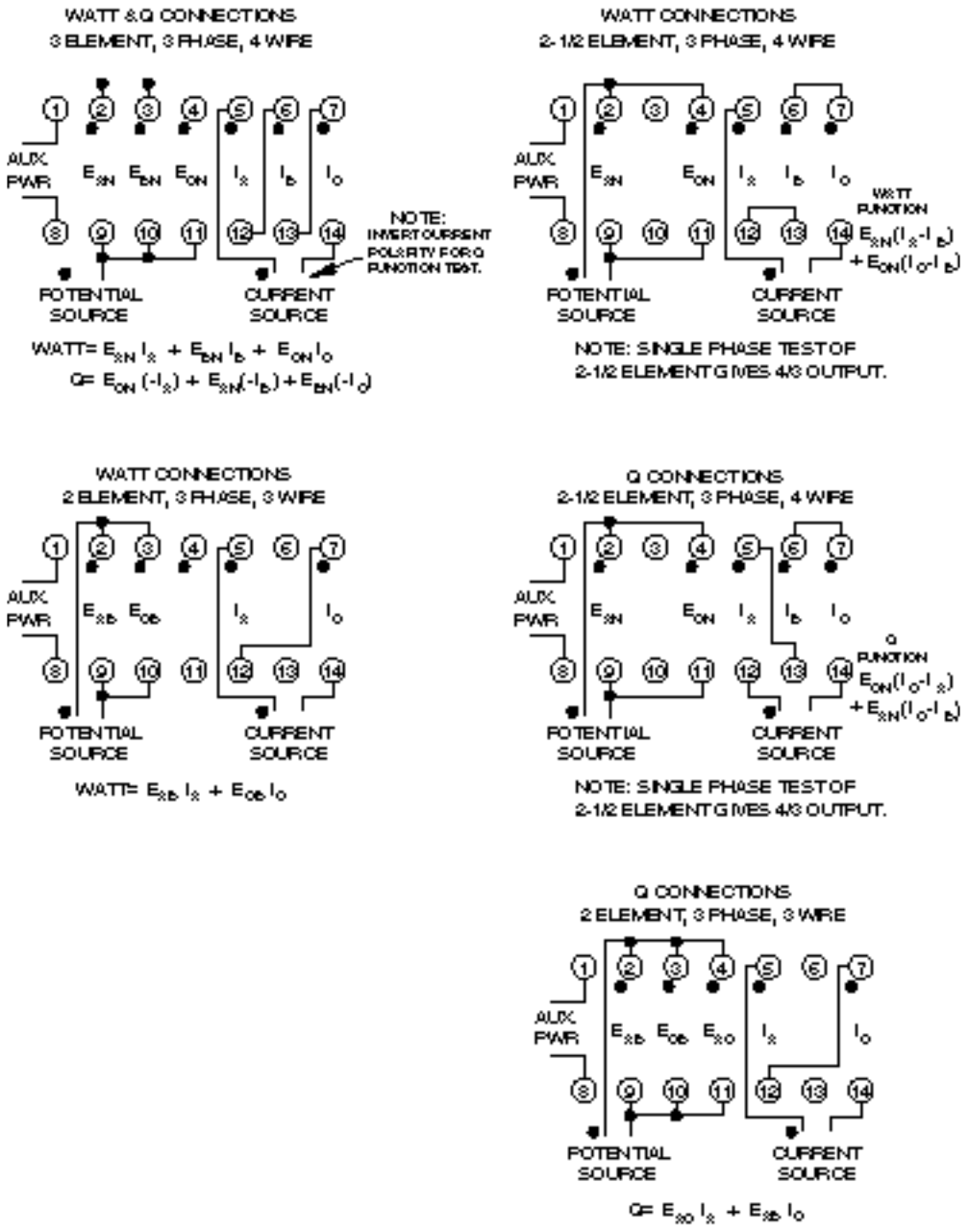


Figure 3-11 Test Connection Diagrams for Single-Phase Testing of 3,

2-1/2, and 2 Element JEM1 Meters

3.7.2. Equations and Relationships

Equations showing the relationships between Volts & Currents for Watts & Q Metering.

2 Element

$$W = E_{AB} I_A + E_{CB} I_C$$

$$Q = E_{AC} I_A + E_{AB} I_C$$

2 1/2 Element

$$W = E_{AN}(I_A - I_B) + E_{CN}(I_C - I_B)$$

$$Q = E_{CN}(I_C - I_A) + E_A(I_C - I_B)$$

3 Element

$$W = E_{AN} I_A + E_{BN} I_B + E_{CN} I_C$$

$$Q = E_{CN}(-I_A) + E_{AN}(-I_B) + E_{BN}(-I_C)$$

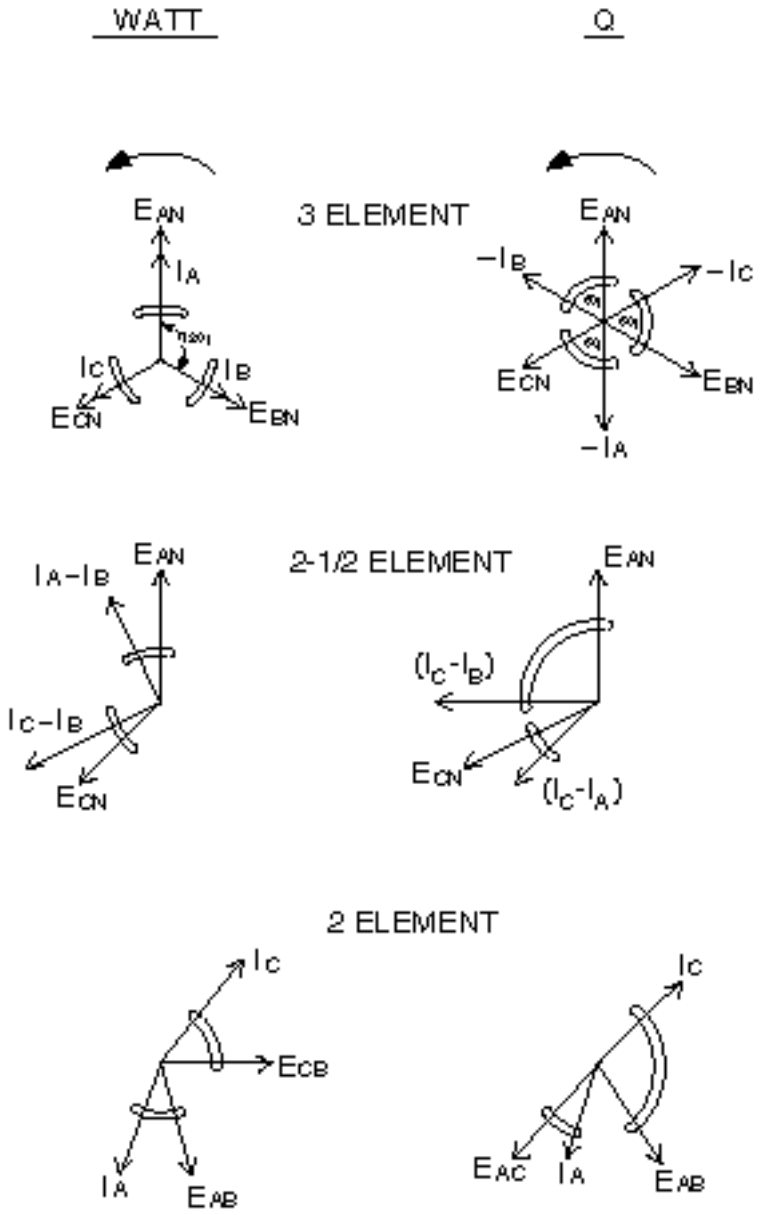


Figure 3-12 Phasor Diagrams for W/Q Metering

3.8. "H" - Option: Dual Current Circuit

The JEM1 "H"-Option allows metering the total of two loads by combining the two current inputs, although only one set of voltage inputs are used. The current signals are added through the magnetic coupling of transformer windings, which gives a secondary current proportional to the Phasor sum. The resulting Watt and/or VAR response (depending upon the type of meter) is the effective net quantity. The validity of this technique depends on the assumption that the voltage input provided is representative of the condition at both metered points.

One set of currents could be connected in opposite polarity which would result in the net difference in the two. If the meter specified is "unidirectional", only the net positive (delivered) result would be registered.

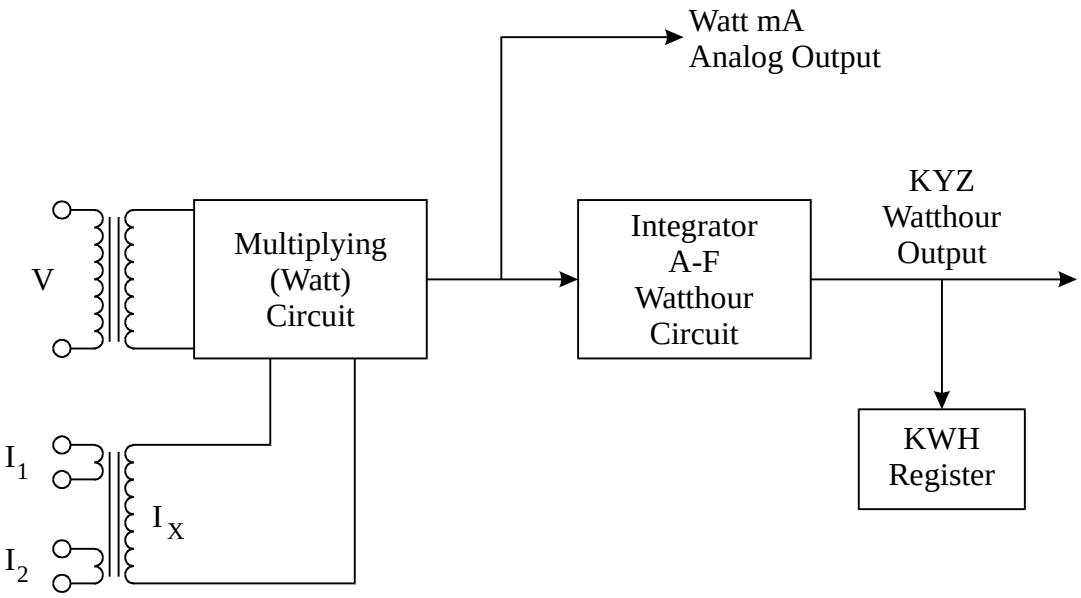


Figure 3-13 Simplified Block Diagram of JEM1 Dual Current Circuit

Since $I_x = I_1 + I_2$ (Phasor sum)

and $W_1 = I_1 \text{ Cos } \theta_1$, $W_2 = I_2 \text{ Cos } \theta_2$,

$W_T = VI \text{ x Cos } \theta = V(I_1 \text{ Cos } \theta_1 + I_2 \text{ Cos } \theta_2)$

$W_T = W_1 + W_2$

3.8.1. H - Option Features

- Dual Current Circuit for totalizing applications
- Calibration: Nominal full scale is 5A per current circuit; 120V giving:
  3 element = 3600 watts
  2 element = 2400 watts
- Maximum operating level is to 200% of nominal (10A on all circuits)
- Analog output is 1.20mAdc at nominal (5A, 120V) inputs; 2.40mA maximum
- Ke (watthour constant) = Nominal FS watts/ CPH

example: $\frac{3600W}{} = 1.0$ Wh/count

- 3600cph
- can be specified from 200 cph to 26,000 cph
- Current circuits are low burden
- Mechanical: Available in back connected (B or P) or front connected (F option). Units are approximately 2" higher than standard JEM1 meters.
- Available in all standard JEM1 models, allowing multifunction capability (Watt Wh, VAR VARh) and bi-directional operation where applicable.
- Available with all other JEM features and options such as dual demand displays and serial communication options.

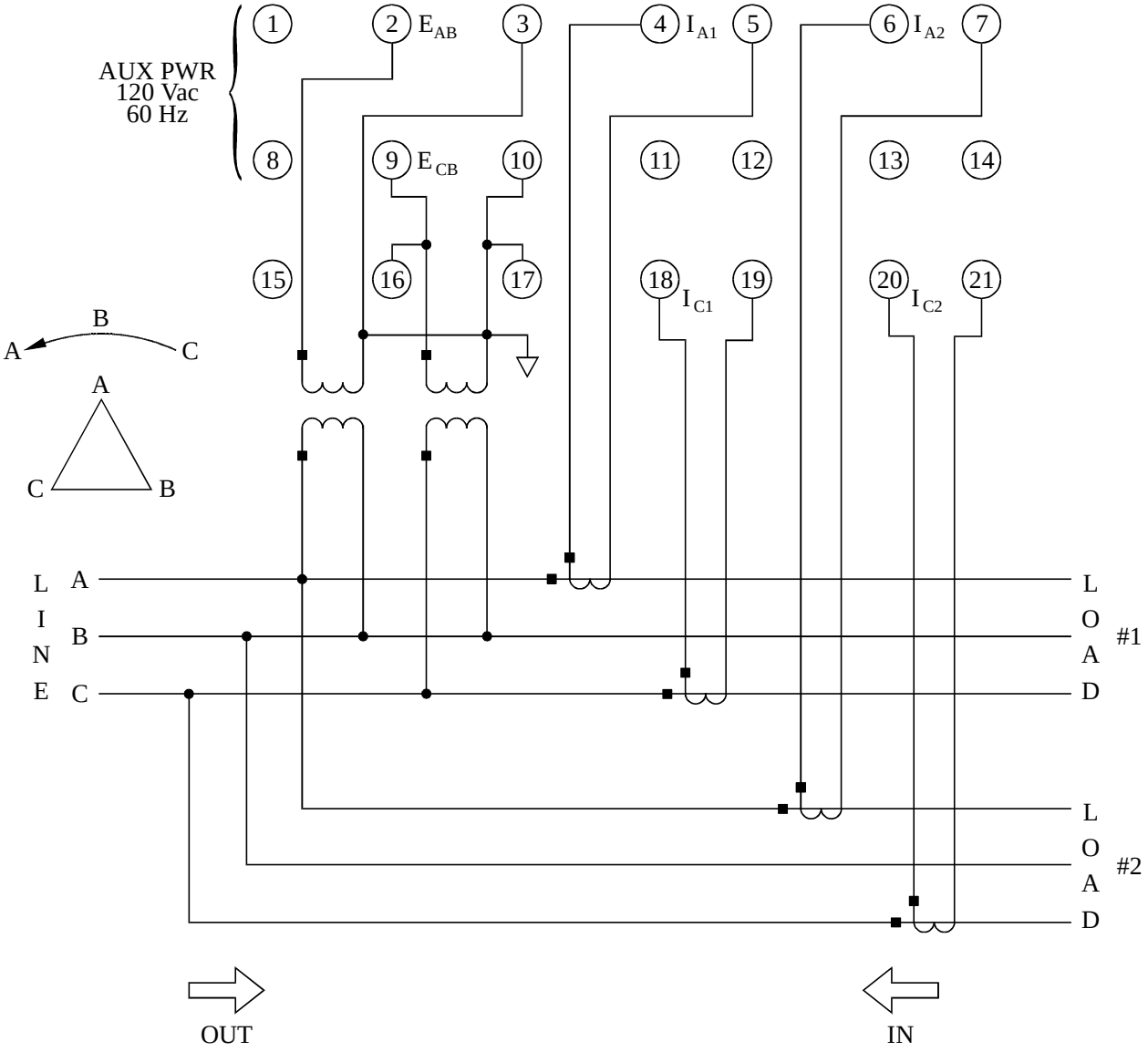


Figure 3-14 2 Element, 3-Phase, 3-Wire Dual Current (H-Option)

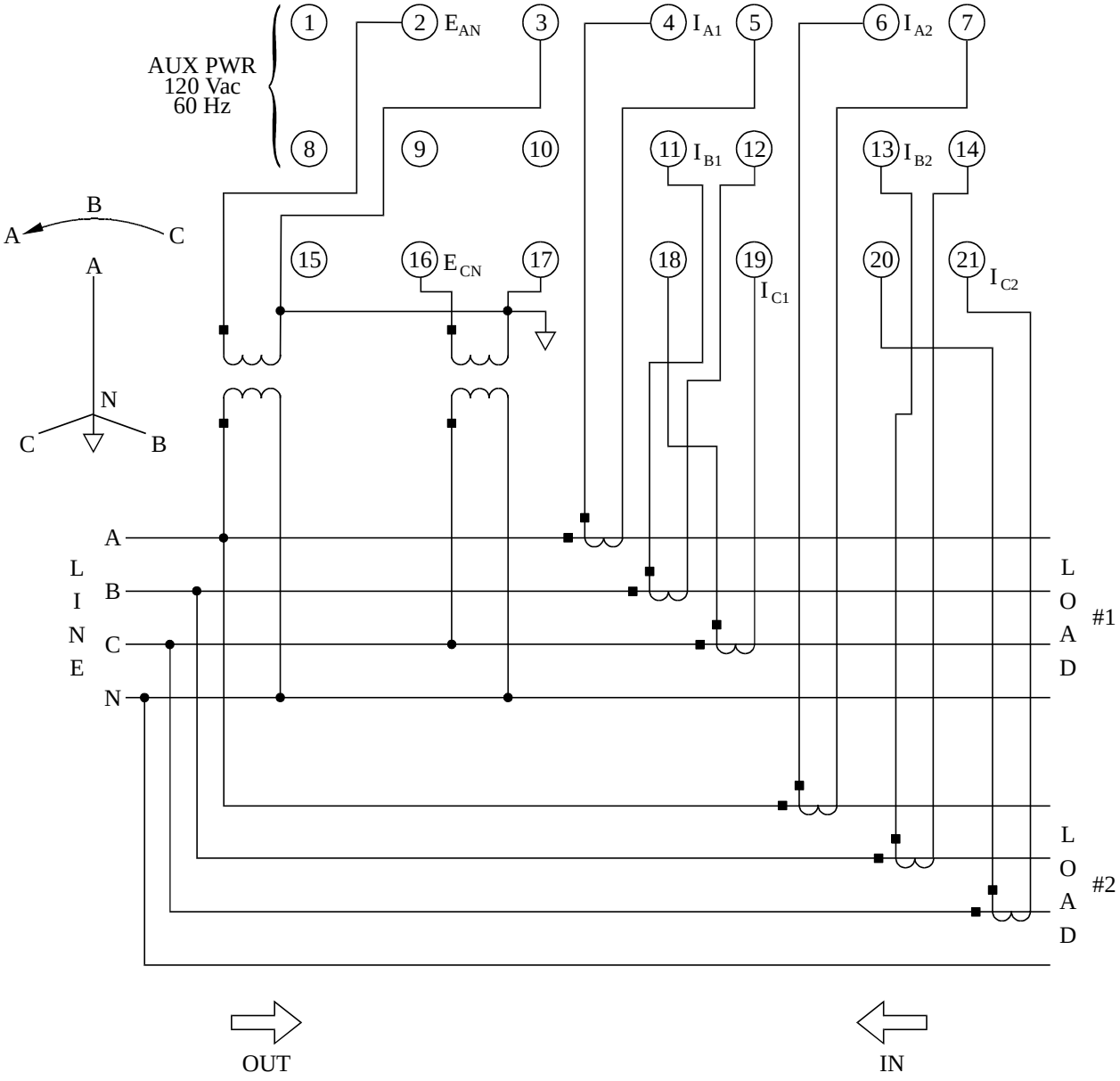


Figure 3-15 2-1/2 Element, 3-Phase, 4-Wire Dual Current "H" - Option

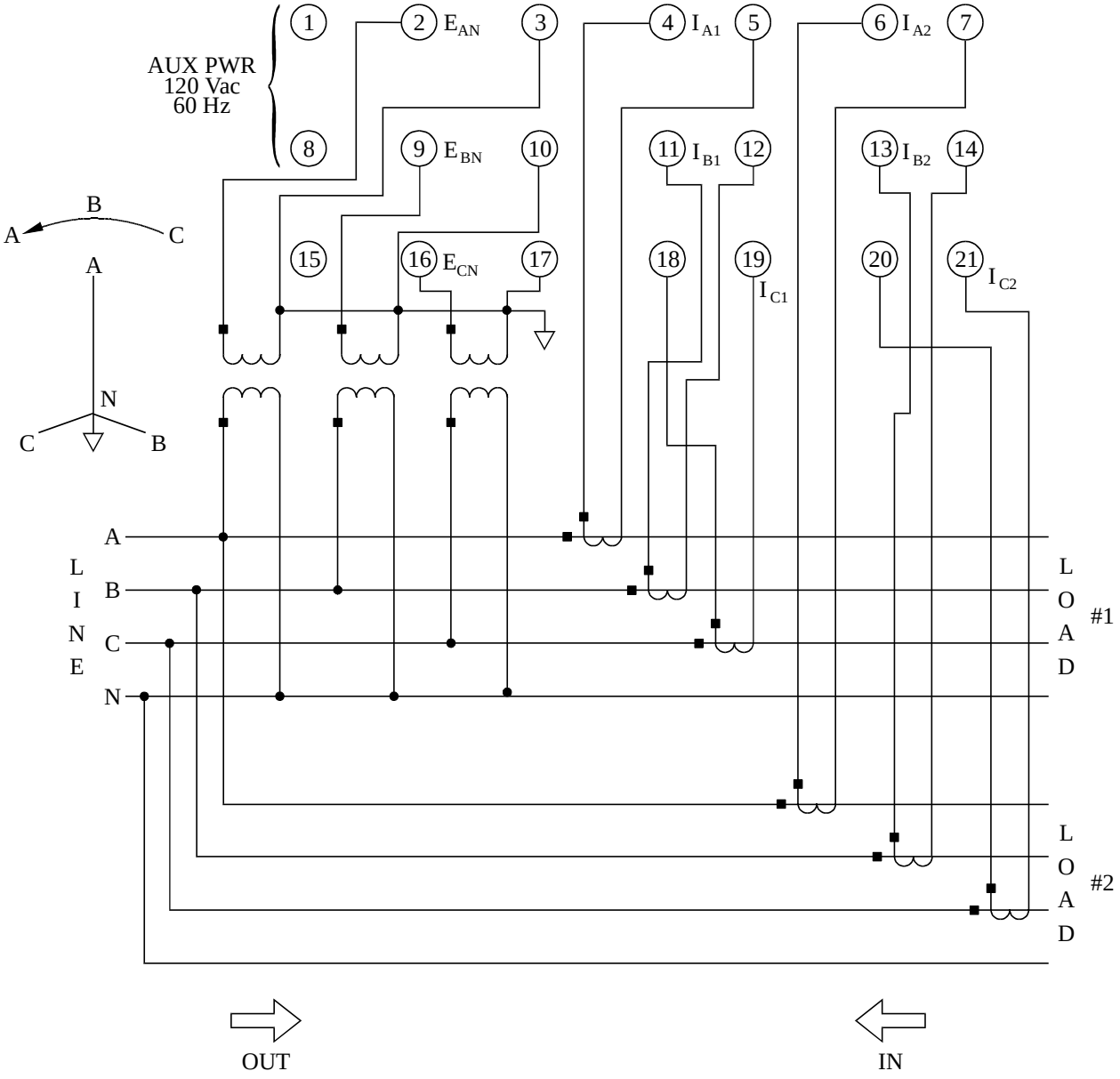
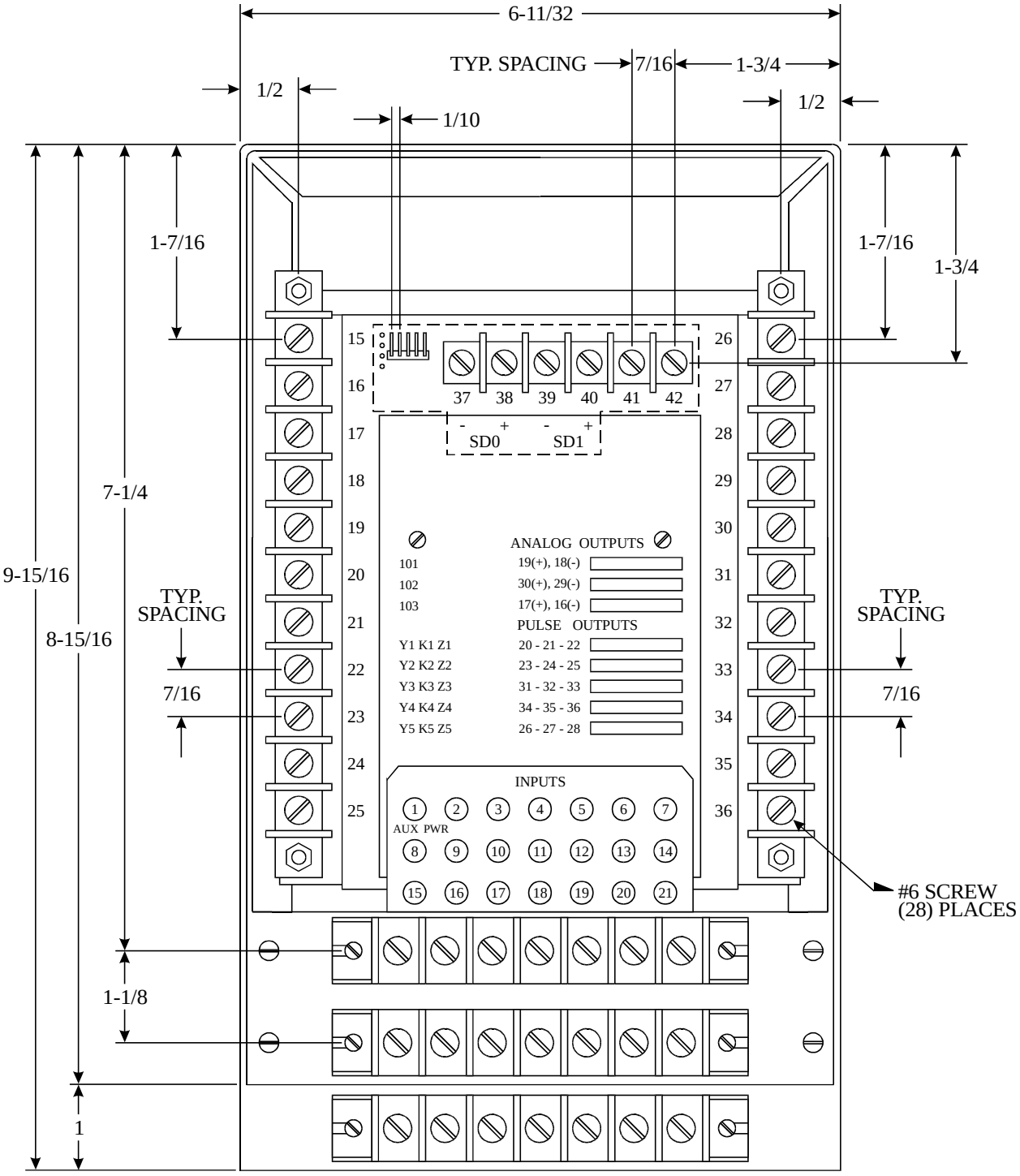
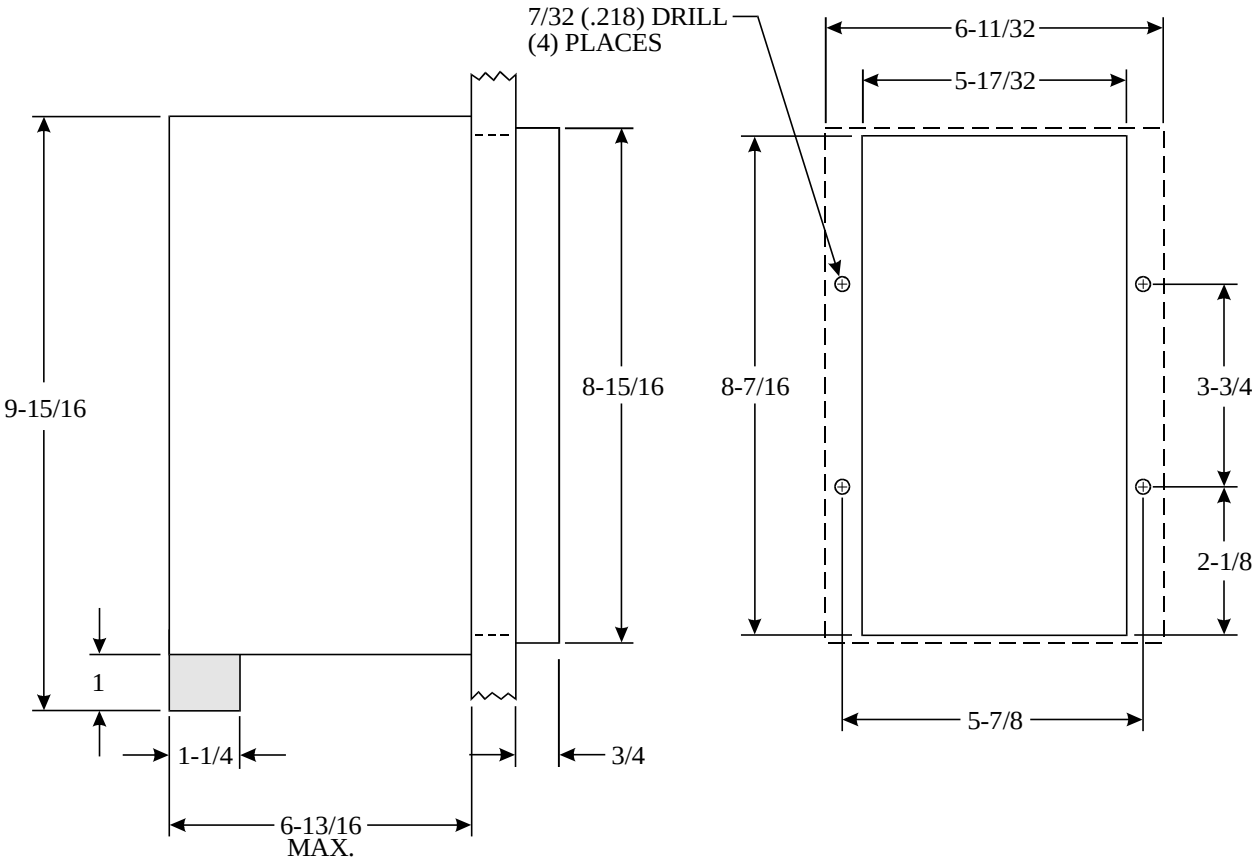


Figure 3-16 3 Element, 3-Phase, 4-Wire Dual Current "H" - Option


6-11/32
TYP. SPACING
7/16
1-3/4
1/2
1/2
1/10
1-7/16
1-7/16
1-3/4
7-1/4
9-15/16
8-15/16
TYP.
SPACING
TYP.
SPACING
7/16
7/16
1-1/8
1
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37 38 39 40 41 42
- + - +
SD0 SD1
ANALOG OUTPUTS
101
102
103
19(+), 18(-)
30(+), 29(-)
17(+), 16(-)
PULSE OUTPUTS
Y1 K1 Z1
Y2 K2 Z2
Y3 K3 Z3
Y4 K4 Z4
Y5 K5 Z5
20 - 21 - 22
23 - 24 - 25
31 - 32 - 33
34 - 35 - 36
26 - 27 - 28
INPUTS
AUX PWR
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
#6 SCREW
(28) PLACES


7/32 (.218) DRILL
(4) PLACES
6-11/32
5-17/32
9-15/16
8-15/16
8-7/16
3-3/4
2-1/8
1
1-1/4
3/4
5-7/8
6-13/16
MAX.

3.9. SWITCHBOARD CASE OPTION for JEM1

INTRODUCTION

This section provides information unique to the switchboard models of the JEM®1 meter.

Models

All models generally available in non-switchboard packages are available in the switchboard package.

Model numbers are the same, differing only in that the suffix SW is added to the model number. For example, a Model 513 becomes a Model 513SW.

Compatibility

JEM1 SWITCHBOARD METERS ARE "SERVICE CONNECTION" COMPATIBLE WITH JEMTEC ELECTRONICS COMPANY JEM®2 AND JEM®3 METERS AND EXCEPT FOR COMMUNICATIONS CONNECTIONS, MAY BE INTERCHANGED IN A GIVEN INSTALLED OUTER CASE

DETAILS IN THE OUTER CASE AND MATING PHYSICAL AND ELECTRICAL INTERFACES HAVE BEEN STANDARDIZED FOR ALL JEMTEC ELECTRONICS SWITCHBOARD MOUNTED PRODUCTS.

Communications connections are necessarily different due to the difference in functionality of the JEM1, JEM2, and JEM3 products. (See "Communications" section of this addendum.)

Function Boards

The function boards in switchboard models of the JEM1 meter are the same function boards as those used in other models of the JEM1 meter and are interchangeable.

The only incompatible element on function boards is the SLOW COUNT OPTION MODULE USED ON THE INTEGRATOR BOARDS. This is a plug-in module for which a surface mount, low profile version has been developed in conjunction with the switchboard adaptation. The low profile version of the slow count module replaces the older stacked version and will work on any JEM 1 meter.

THE OLDER STACKED VERSION OF THE SLOW COUNT MODULE WILL NOT WORK ON SWITCHBOARD MODELS DUE TO PHYSICAL CLEARANCE LIMITS IN THE SWITCHBOARD CASE.

REGISTERS

Switchboard JEM1 meters are available only with the EXJ register.
Older EXJ registers, electromechanical registers and coed registers cannot be used.

PREPARATION AND INSTALLATION

Auxiliary Power Connections

The JEM1 Switchboard Meter is shipped with two optional means of connecting auxiliary power.

> **CAUTION!**
> The auxiliary power jumper plug may be used only when rated auxiliary power voltage and rated "A" phase voltage are the same. To do otherwise may permanently damage the meter.

Auxiliary power can be externally connected by using the external auxiliary power pigtail assembly, Part No. 13672-001K, supplied with the meter.

The external auxiliary power pigtail is required when the auxiliary power voltage rating differs from "A" phase voltage rating and is connected to any external supply.

When using Phase “A”, use part no 13673-001K plug with two black jumpers installed.

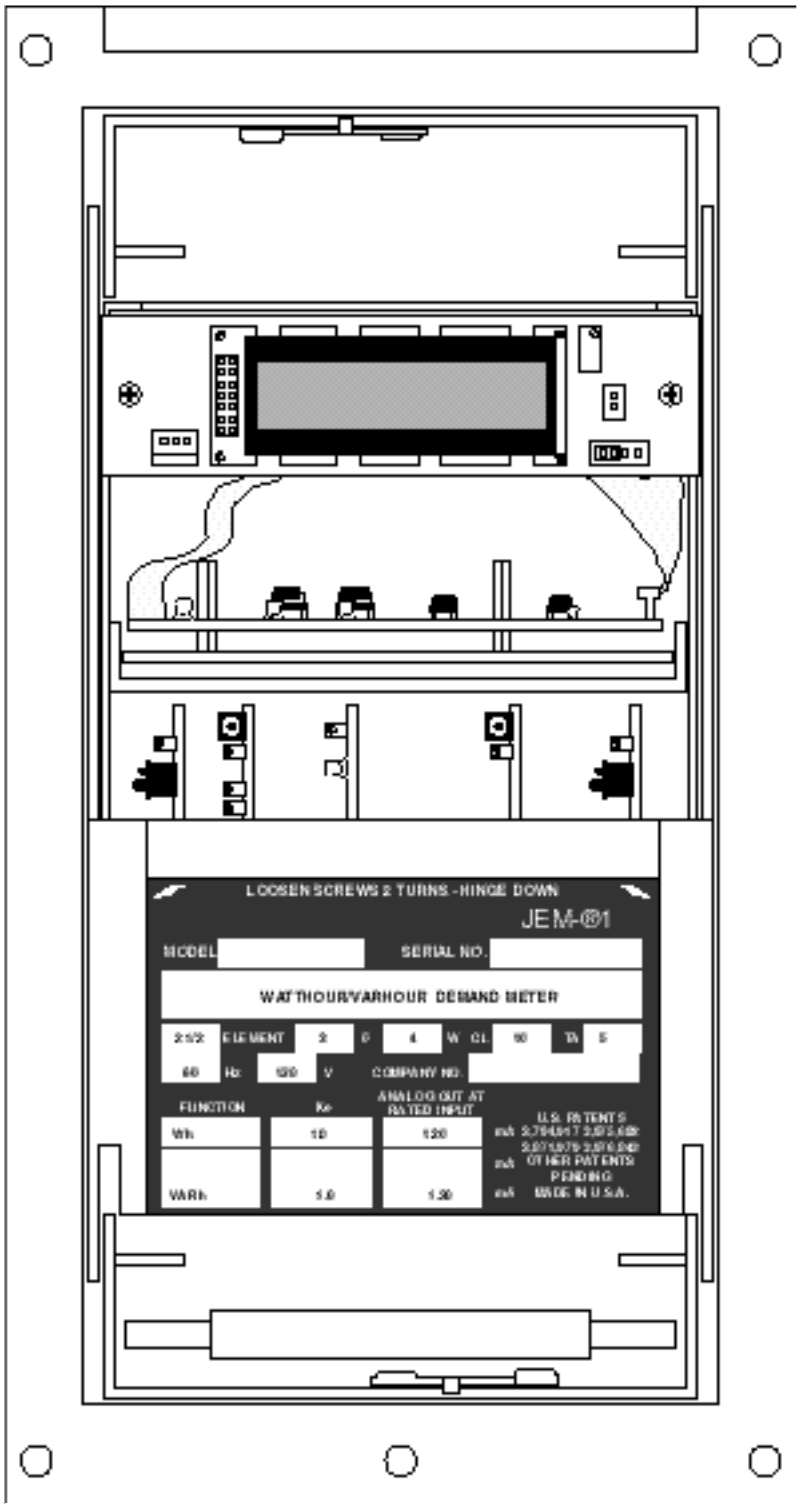


Figure 3-17 Typical Switchboard Front View with Cover Removed

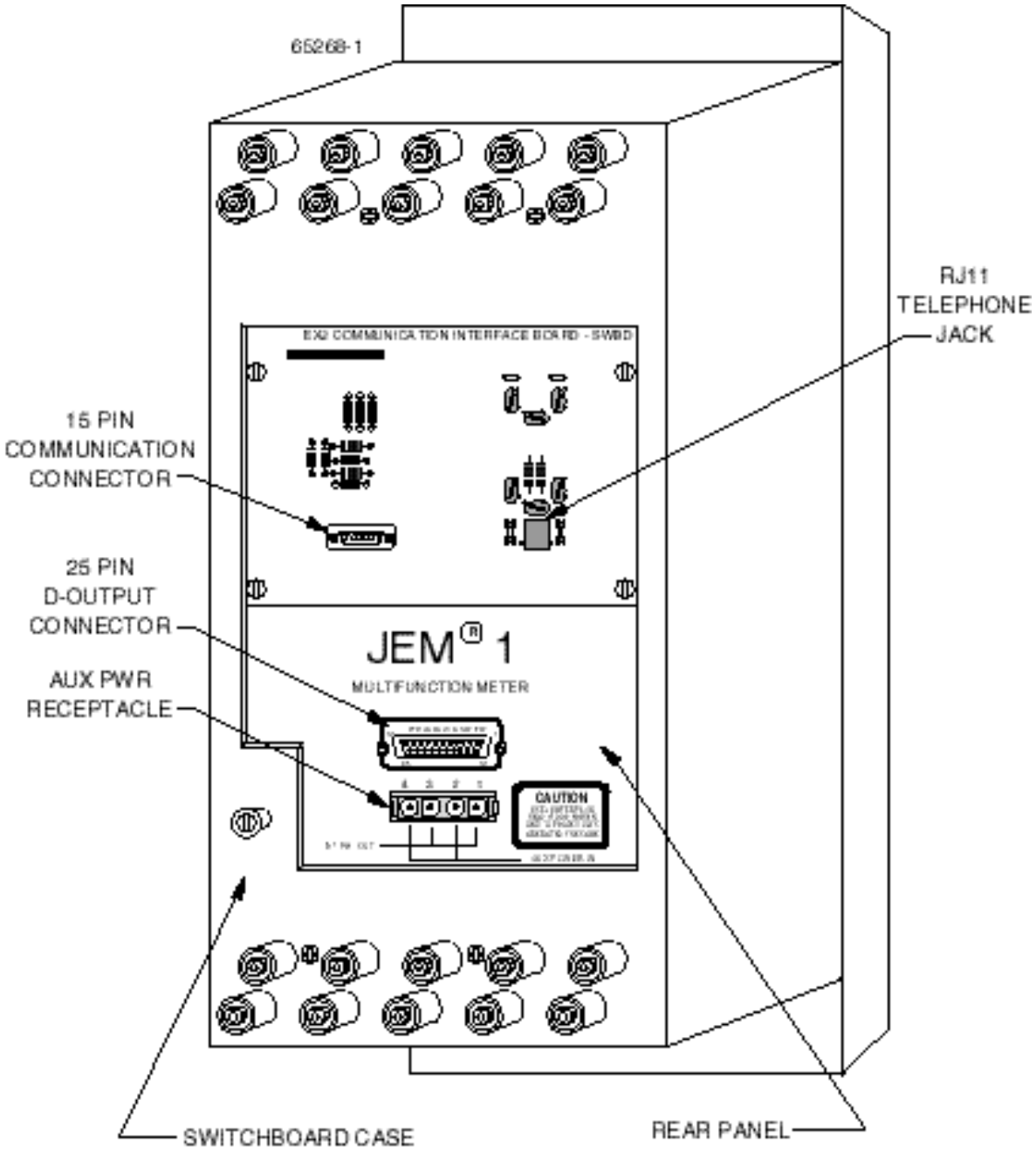
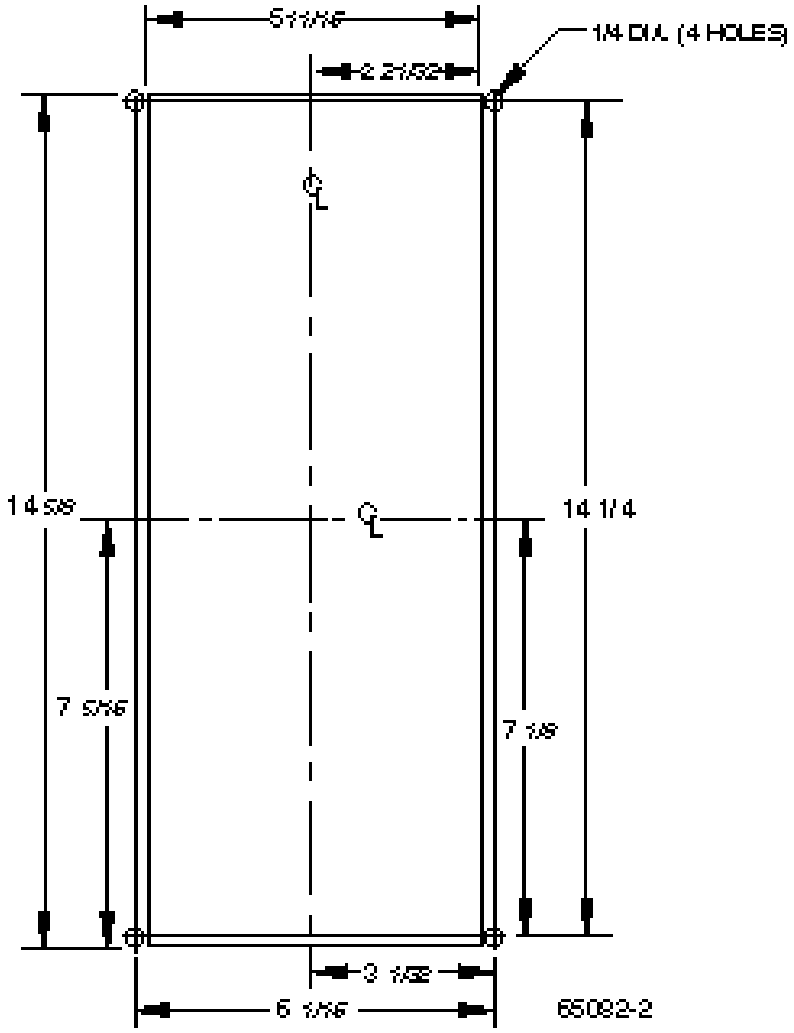


Figure 3-18 Rear View of the JEM1 Switchboard Case

Mounting Dimensions

See the figure below for panel cutout, mounting hole locations and rear panel clearance requirements.



MOUNTING DETAILS
M1 CASE - 20 Terminals

NOTES:

CASE DEPTH IS 7 INCHES FROM FRONT OF THE PANEL
RECOMMENDED BACK PANEL CLEARANCE IS 10 INCHES FROM FRONT OF PANEL.

DIMENSIONS ARE IN INCHES

Figure 3-19 Switchboard Cutout Dimensions

Service Connections

There are three basic service connection diagrams that serve most models of the JEM1 Switchboard Meter: These service connections are identical, form for form, to service connections for JEM2 and JEM3 service connections.

The three basic forms are:

Form 5 switchboard 2 element, 3 phase, 3 wire DELTA.

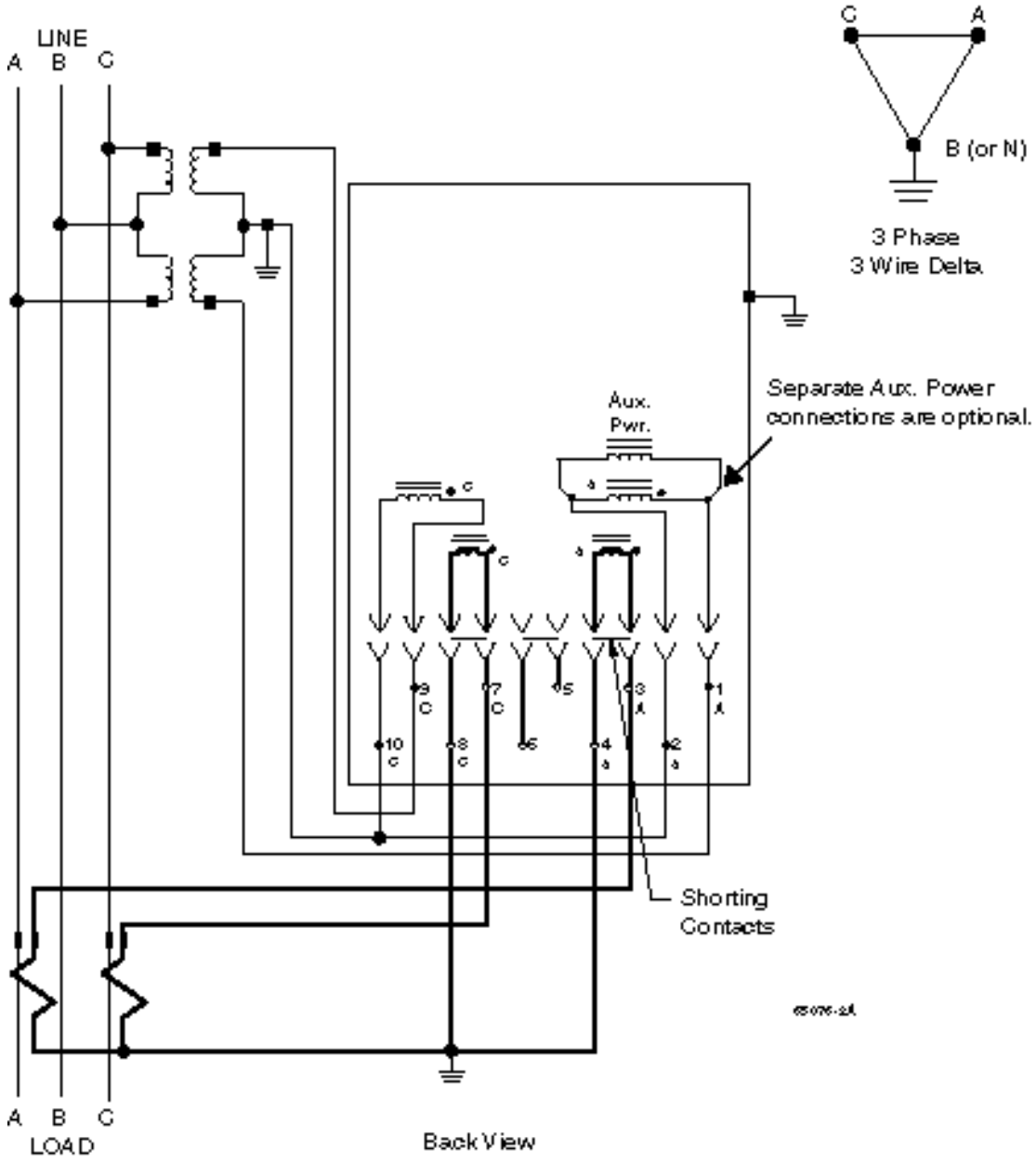


Figure 3-20 Form 5 Switchboard 3 Phase, 3 Wire Delta, 2 Element

Form 6 switchboard 2 1/2 element, 3 phase, 4 wire WYE.

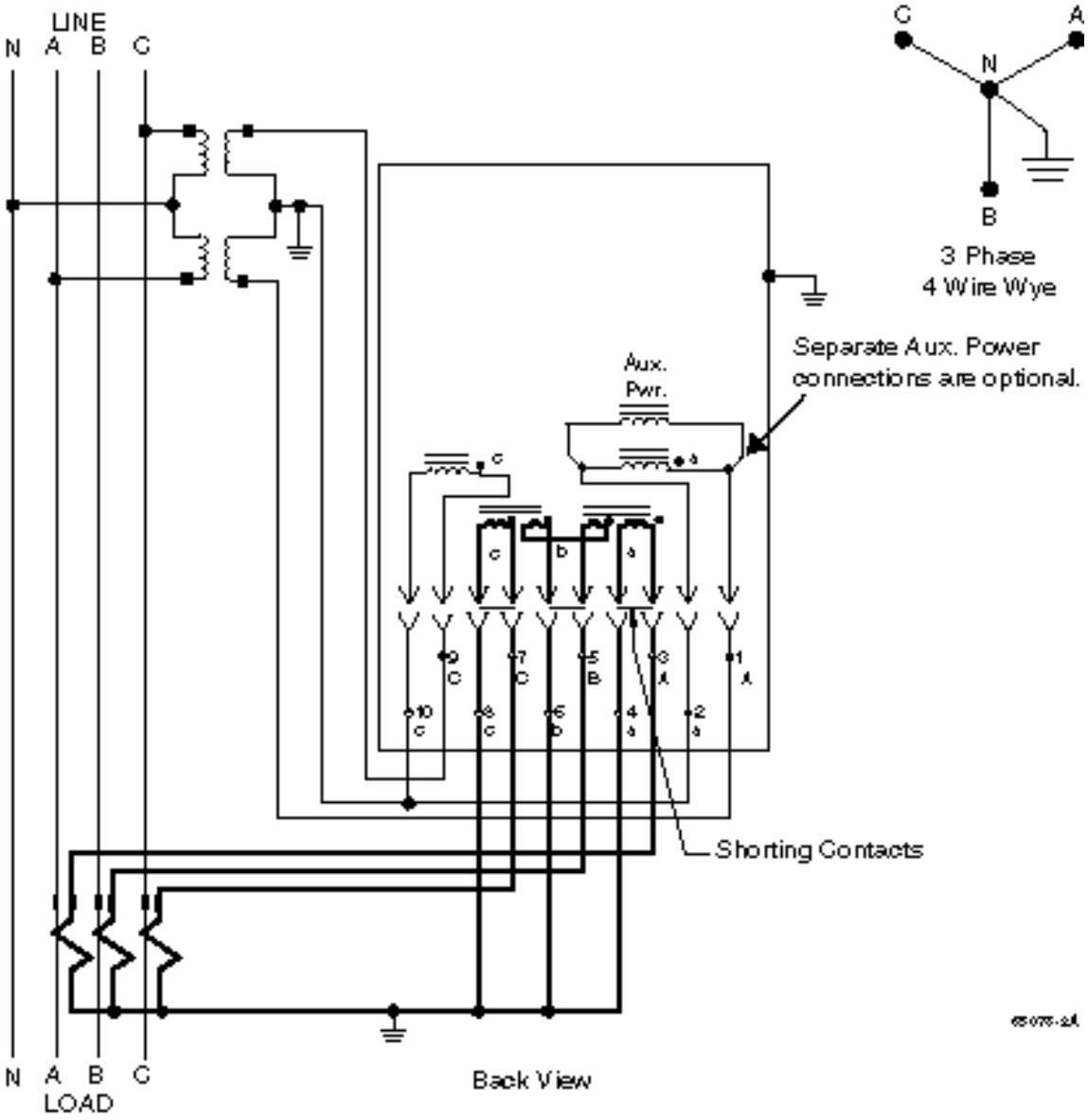


Figure 3-21 Form 6 Switchboard 3 Phase, 4 wire Wye, 2 1/2 Element

Service Connections (continued)

Form 9 Switchboard 3 element, 3 phase, 4 wire WYE.

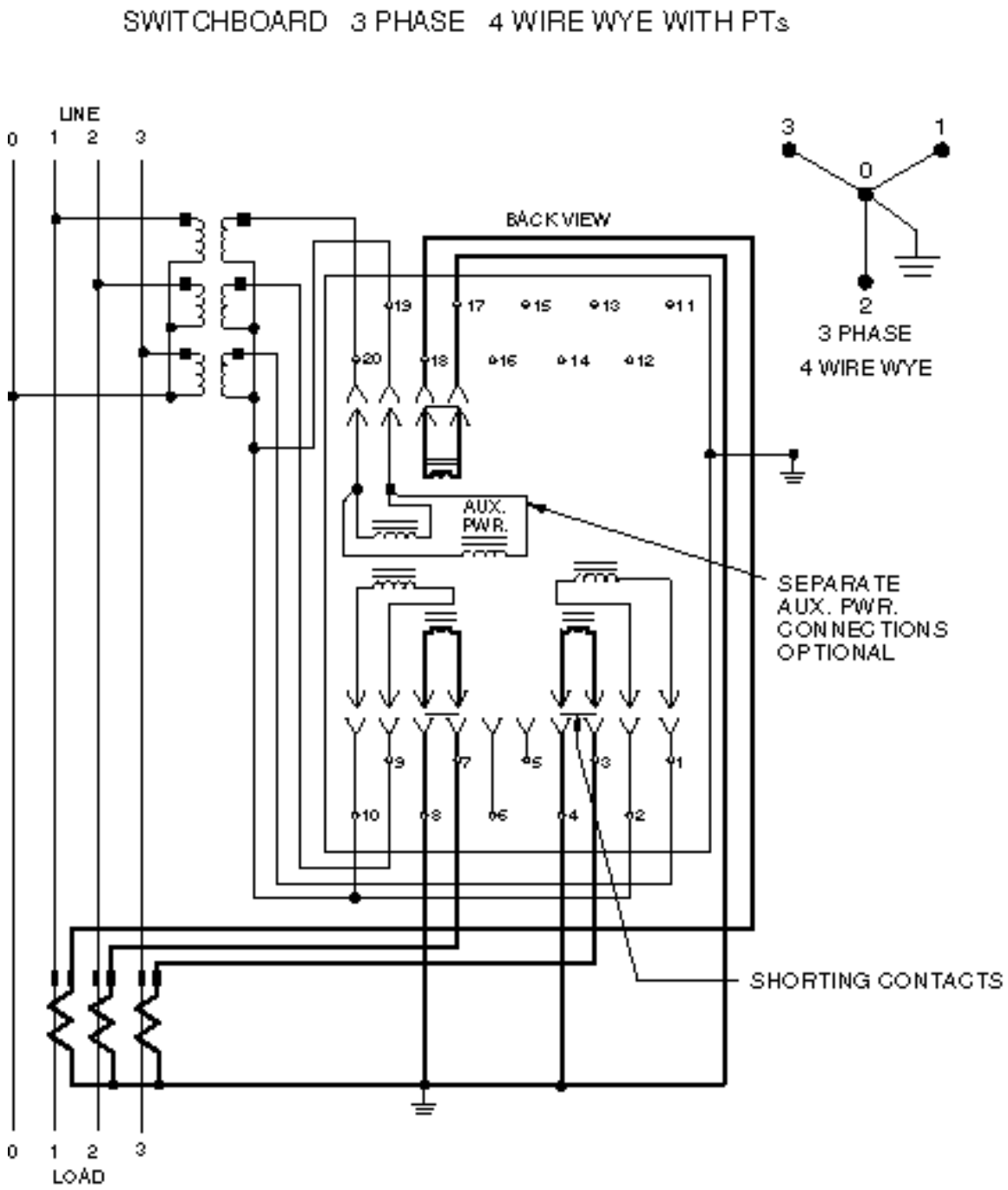


Figure 3-22 Form 9 Switchboard 3 Phase, 4 Wire Wye

Communications Connections

Communication with the JEM1 Switchboard Meter is the same as for non-switchboard models.

Serial communication with the JEM1 Switchboard Meter is achieved through an optical port located on the front of the meter or through either of two 15 pin miniature "D" connectors. One is located on the front of the meter and the other on the rear of the meter. Communications via the 15 pin connectors is RS232C or 20 mA Current Loop. (See Figure 3-23 for pinout of the 15 pin "D" connectors.)

Optional Telephone MODEM - An *option* on the EXJ Register

An RJ-11 phone jack is located on the rear of the meter. This jack is on all meters whether or not the MODEM option has been supplied with the meter. This permits easy retrofit of an internal MODEM at any later time.

EXJ™ Register 15-Pin "D" Connector Pinout

This 15-pin "D" connector on the front panel may be used for serial communication.

PIN NUMBER	FUNCTION
1	No Connect
2	RTS (RS-232 Output)
3	TXD (RS-232) Output
4	-TXD Current Loop
5	+TXD Current Loop
6	-RXD Current Loop
7	+RXD Current Loop
8	No Connect
9	DTR (RS-232 Output)
10	GND (RS-232)
11	RXD (RS-232) Input
12	-End of Demand Interval Pulse
13	+End of Demand Interval Pulse
14	-R Option (20mA)
15	+R Option (20mA)

*NOTE: The 15 pin connector on the back is the same except RTS (Pin 2) is not connected.

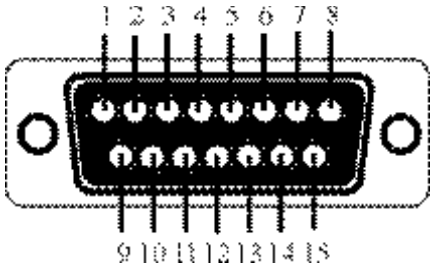


Figure 3-23 15 Pin D Connector

EXJ™ Register 25-Pin "D" Connector Pinout

25-pin "D" connector pulse and analog output signals identification

PIN NUMBER	FUNCTION	COLOR
1	IO_1(+)	Brn
2	IO_2(+)	Red
3	IO_3(+)	Org
4	Case Ground	Blk
5	Y_1	Grn
6	K_1	Blue
7	Z_1	Vio
8	Y_2	Gry
9	K_2	Wht
10	Z_2	Wht/Blk/Brn
11	Y_3	Wht/Brn
12	K_3	Wht/Red
13	Z_3	Wht/Org
14	IO_1(-)	Wht/Yel
15	IO_2(-)	Wht/Grn
16	IO_3(-)	Wht/Blue
17	Case Ground	Blk
18	Y_4	Wht/Gry
19	K_4	Wht/Blk
20	Z4	Wht/Blk/Gry
21	Case Ground	Blk
22	Y_5	Wht/Blk/Red
23	K_5	Wht/Blk/Org
24	Z_5	Wht/Blk/Yel
25	Case Ground	Blk

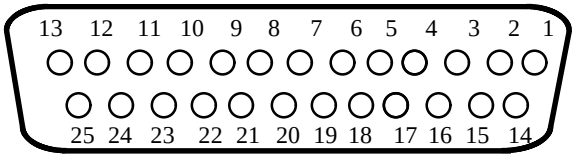


Figure 3-24 25 Pin Connector

3.10. ELECTRONIC DISPLAY/DEMAND REGISTER

This section contains information for the LED style Electronic Register. For EXJ (J Option) operation, refer to Section 4 *EXJ Users Guide*.

Detailed Operating Instructions for the LED Electronic Register (D & E Option JEM1's)

3.10.1. Reading Displayed Data:

The toggle switch located on the front panel is used to select display modes; when left in the Roll (RO) position, the displayed information is sequenced at four second intervals. As the displayed data changes, a function indicator LED lights adjacent to the appropriate screened legend. The typical display as shown in Figure 4.2 would consecutively display as follows:
kWh out, kWh in, kVARh lag, kVARh lead, kWD_p, kWD_c, T.R.(time remaining) and then repeats

Figure 4.6 shows the display sequence.

Unused functions are not displayed. Any reading may be continuously displayed by moving the display control switch to the center Stop (ST) position when that reading is being displayed.

To display cumulative demand, the display is sequenced until the Peak Demand reading is displayed, then the toggle switch is moved through the center and held to the right (CD) position. When released, the Peak Demand reading is again displayed. The display may then be changed to any desired reading by using the Roll and Stop switch positions.

A display test feature is provided so that all digit segments and discrete LEDs can be tested. To initiate the segment test, allow the meter to cycle in the Roll mode until time remaining is displayed, then move the display control switch to the extreme right momentary position. If all display segments are functioning every segment will be displayed and all 6 function indicators will be illuminated.

3.10.2. Demand Reset Pushbutton

Momentary-contact pushbutton, with sealing hole, resets the peak demand value. This switch is located on the upper left of the front panel and resets peak demand to current demand value.

The demand reset is "locked out" for two intervals following the reset action; this prevents accidental double resetting which would result in a false cumulative demand reading.

3.10.3. Load Rate Indicators

LEDs flash at pulse rate determined by calibration and the present load. The LEDs are on the left of the display and are labeled "Load Rate".

3.10.4. Potential Indicators

Three LEDs, located below the display as shown in Figure 4.2, illuminate whenever voltage is applied and remain lit as long as voltage is present.

3.10.5. Battery Power

A long-life battery is provided to retain data in memory during a power failure. See Figure 4.1 for the location of 3V lithium battery. Battery life is expected to exceed five years; therefore, it is recommended that the battery be replaced on a five year schedule to provide adequate assurance of protection against data loss.

***NOTES**: To replace battery - KEEP AUXILIARY POWER APPLIED.*

1. Remove front panel (switch h*arness may be disconnected).*

2. Extend register module out from case to gain access to the battery.

3. Remove old battery and insert new one. NOTE POLARITY.

4. *Replace retainer and slide m*odule back in, connect switch harness and replace panel.

3.10.6. Digit Pair Selector Switch (Advance)

Data of any function may be changed to any desired value by the following procedure:

1. Remove front panel (*leave switch harnesses connected)* and slide register module out one or two inches.

2. Stop display with Roll/Stop toggle switch on data to be altered.

3. Three-position rocker switch is mounted on the right side of the display board as shown in Figure 4.2. This advance switch is used to select one of three digit sets to be adjusted as identified in Figure 4.3.

4. NOTE: For all functions except time, SWI (top) selects the least-significant digit (LSD) and the second digit. SW2 (middle) chooses the third and fourth digits, while SW3 (bottom) selects the fifth and sixth digits (shown as D0 through D5 in Figure 4.3). Time may be changed with SWl (for seconds) and SW2 (for minutes) as indicated in Figure 4.4.

5. With a pencil, stylus, probe, or other similar device, push right side (marked ON) of the rocker switch to advance the digits.

6. Push left side of rocker switch when desired number is reached.

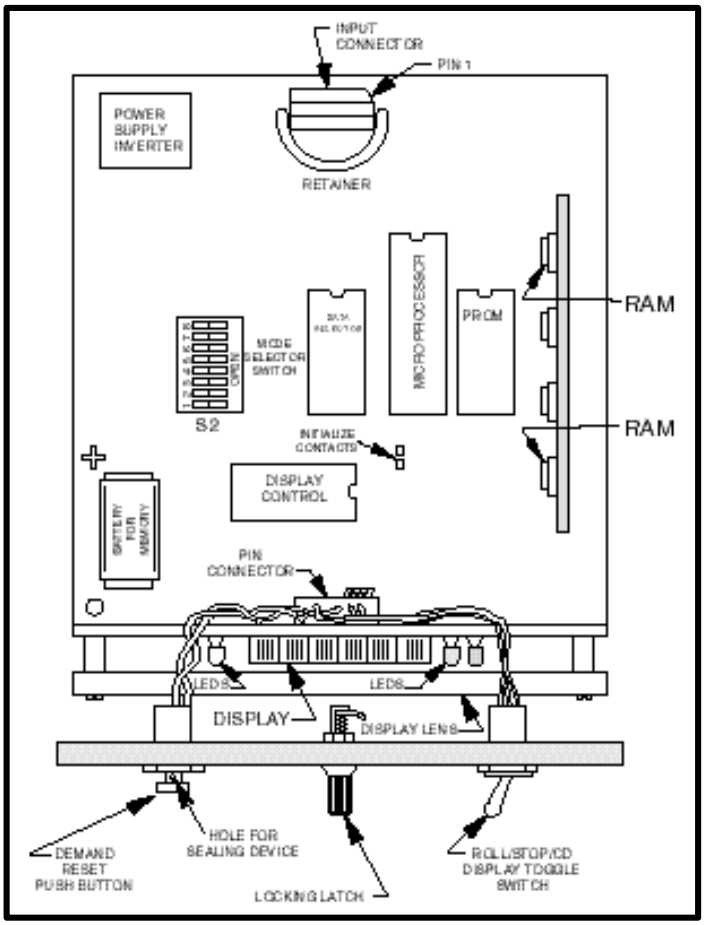


Figure 3-25 Electronic Display/Demand Register Assembly

Field Programmable Variations:

An 8-pole rocker switch (mode selector switch) located on the register main printed-circuit board, (see Figures 4.1 and 4.5), may be used to select variations as outlined below:

a) Demand time Interval:

Interval	S2-1	S2-2
15 Minutes	Closed	Open
30 Minutes	Open	Closed
60 Minutes	Open	Open

b) Register Divide Constant:

Divides all pulse input registration by selected constant; does not divide demand count.

Constant	S2-3	S2-4
1	Closed	Closed
10	Closed	Open
100	Open	Closed
200	Open	Open

c) Display Selection:

	S2-5	S2-6	S2-7
Single Function	Closed	Closed	Closed
Single Function and Demand	Closed	Closed	Open
Dual Function	Closed	Open	Closed
Dual Function and Demand	Closed	Open	Open
Triple Function	Open	Closed	Closed
Triple Function and Demand	Open	Closed	Open
Four Functions	Open	Open	Closed
Four Functions and Demand	Open	Open	Open

d) Initialize:

Whenever a field change as shown above in (a), (b), or (c) is performed, the register should be re-initialized. This is performed by shorting two post (initialize) contacts near the front center of the register printed-circuit assembly (see Figure 4.1). *All register readings are zeroed by this action.*

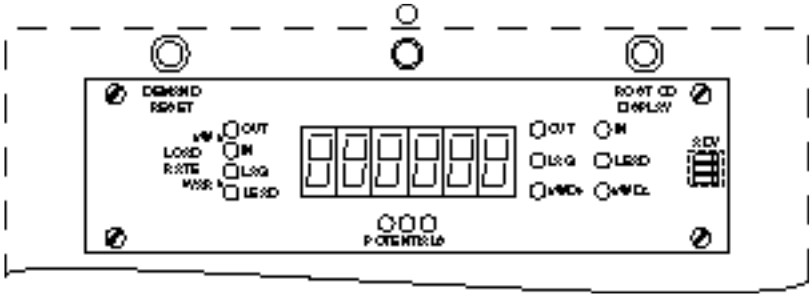


Figure 3-26 Front Panel and Display with Controls (D &E Option)

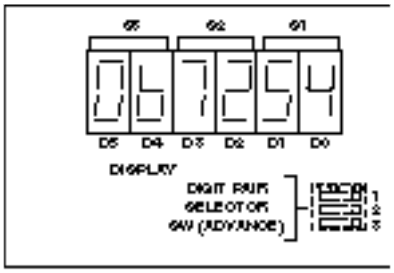


Figure 3-27 Display Data (D & E Optine)

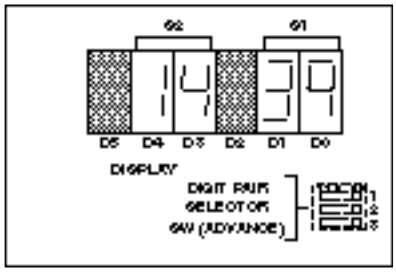


Figure 3-28 Time Display (D & E Option)

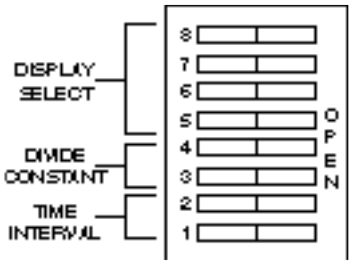


Figure 3-29 Mode Selector Switch (D & E Option)

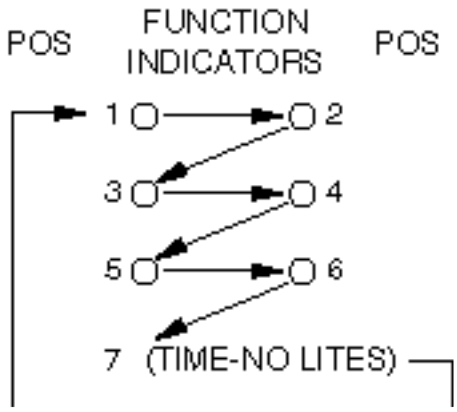


Figure 3-30 Function Sequence (D & E Option)

3.11. Electronic (D & E) Register Specification

This section contains information on Electronic (D & E Option) and Electro Mechanical Register Specifications. For EXJ information, see Section 4 *EXJ Users Guide*.

FUNCTION INDICATORS:

(D & E Option)	Red, discrete, LED lamps light sequentially to indicate which function is being displayed.
Display	Numeric data is displayed on a 6-digit, 7-segment light-emitting diode display. Digits are 3/8" high.

DISPLAY INFORMATION:

Functions	Up to four functions
Demands	Peak demand and the current interval demand count are displayed sequentially with other readings. Cumulative demand is displayable by command from a front-panel switch.

FIELD PROGRAMMABLE VARIATIONS:

Demand Intervals-- 15, 30, 60 minutes

Divide Constant-- l, 10, 100, 200

(This constant does not divide the demand values except for 200 in which the demand values are divided by 2.)

BATTERY:

Type-- A 3-volt, 1-amperehour, lithium non-rechargeable cell is used to maintain data when auxiliary power is removed. *Recommended replacement schedule is five years.*

OPTIONAL END OF INTERVAL SIGNAL:

EODIP Output — A momentary transistor closure pulse (T Option) is available to provide an output at the end of the demand interval.
Voltage Rating, V_{ce}, 25 Vdc
Current Switching I_c, 5 mA dc
Pulse Time, t_p, 16.6 msec.

Electro-Mechanical Register Specification

Counters — 6-digit electro-mechanical counters on the register assembly with individually compensable digits. Operating life expectancy is in excess of 60 million counts. Maximum count speed is 4 counts/second or about 15,000 counts/hour. Normally, register units are the same as pulse outputs; however, register ratios of 1/10, 1/100, and 1/200 are available options. See Calibration Ranges for specific rates.

4 EXJ Register Users Guide

The SCIENTIFIC COLUMBUS EXJ™ Register is a multi-function programmable register/communications controller that may be installed in any of the JEM®1 family of electronic meters. As opposed to the traditional mechanical registers previously used in the JEM 1, the EXJ Register may be configured by the user to operate with **any** JEM 1 meter. In addition, the EXJ Register contains a non-volatile, real-time clock, a non-volatile data memory, and serial communications hardware compatible with current loop, optical and RS-232C/V.24 interfaces.

The EXJ Register is a direct replacement for all JEM 1 register types, both mechanical and electronic, and may be installed with essentially no modification to the JEM 1. Usually, the only parts required are the EXJ Register itself and a new faceplate for the JEM 1 enclosure. Except for the optical port and one external serial port, the EXJ Register uses all of the JEM 1 meter's existing connections. Optional features include an on board auto-answer modem and a "load-profile" memory system.

To increase flexibility in field data reading, the EXJ Register includes a liquid-crystal display of two lines with eight characters each with built-in backlighting. The display provides both numeric and user-defined textual data for any combination of JEM 1 functions. Display formats, pulse divisors, demand times, and serial data parameters are all user-programmable.

This manual is designed for personnel responsible for the initial setup, testing, and installation of the EXJ Register and its supporting hardware. The user should be familiar with accepted metering practices and safety measures.

This manual contains information regarding physical description, operation, specifications, testing, and service connections for the EXJ Register.

4.1. ADDITIONAL REFERENCE DOCUMENTS

EXJ™SET Manual	YD-09493-001-N
Retrofit Guide for EXJ™ Register	YD-09492-001-N
JEM®2 Binary Protocol Load Response	QL-12805-001-A
Maintenance Manual for the JEM®1 Series	YF-09175-001-N
EXJ™ Addendum to the JEM®1 Maintenance Manual	YF-13592-001-N

4.2. SPECIFICATIONS

Electrical

Power Requirements

Voltage:	+14/-14 Volts DC (Supplied by JEM 1)

Input/Output

Inputs:	8 pulse inputs from JEM 1 integrator board(s) (4 pulse inputs and 4 load-rate inputs) Frequency (Monitored for calculations and clock sync): 50 or 60 Hz
Outputs:	Serial data communications (optical, current loop, and RS-232C/V.24-compatible) EODIP Form A output
Transmission Speed:	300/600/1200 baud

Mechanical

Physical Dimensions

Height:	1-1/2" (38.1 millimeters)
Length:	5-11/16" (144.46 millimeters)
Width:	5-1/2" (139.7 millimeters)
Weight:	11 ounces (310 g)

Environment

Temperature:

Storage:	-20°C to +70°C.
Operating:	-20°C to +70°C.

Relative Humidity:

0 to 95%, non-condensing.

Current Loop, Serial I/O Device Ratings

VSAT
Transmitter Output = 2.7 Vdc (maximum @ I_C = 20 mA)

VON
Receiver Input = 1.7 Vdc (maximum @ IC = 20 mA)

VOC
Maximum open circuit
compliance of current source = 27 VMAX

R & T Option

R option input:
Rated Forward Voltage V_F = 1.50 Volts maximum @20mA
Maximum Forward Current = 60mA

T option output:
V_{CE} = 30 Volt maximum
I_C maximum = 30 mA

$V_{CE\ SAT}$ = 2V @30mA

Clock

A. Accuracy

When not Auxiliary Power line synchronized ±35 ppm @ 25°C

Exactly follows Auxiliary Power line oscillations when the clock is line synchronized.

B. The clock integrated circuit chip contains nonvolatile memory for configuration information. This clock chip contains an embedded energy cell, and this integrated circuit (U5) has a life expectancy in excess of ten years. An exception to this is when the power is removed or the meter is otherwise de-energized for an extended period of time.

Storage/Life	@70°C Greater than 10 years
Storage/Life	@50°C Greater than 50 years
De-energized[11]	Greater than 3 years

[11] For long term shortage of the EXJ it is recommended the unit be put into "hibernation". This is done by sending the "ZZ" hibernate command to the register.

Load Profile Memory (Mass Memory Option)

Load profile memory contains embedded energy cells. These integrated circuits (U4 and U6) have a life expectancy in excess of ten years.

Storage/Life	@70^{O}C Greater than 10 years
Storage/Life	@50^{O}C Greater than 50 years

Modem (Optional)

Bell 103/212A Compatible (1200bps)
Auto answer
Auto Baud
Ring count before answer (programmable from 1 to 16)
Answer time window (programmable start HH:mm to stop HH:mm)

4.3. INSTALLATION

NOTE:
The EXJ Register should be configured for the JEM 1 in which it is to be installed. Consult the EXJSET INSTRUCTION MANUAL for further data.

WARNING!
For safety reasons, the JEM 1 case should be electrically connected to ground. Failure to ground the chassis could result in electrical shock.

Consult the *JEM®1 Instruction Manual* (SCIENTIFIC COLUMBUS Part Number (YD-08787-001-N) for input/output connections.

4.3.1. Retrofit

For retrofit information, please refer to the *Retrofit Guide for EXJ™ Register* (Part Number YD-09492-001-N).

4.3.2. Display Contrast Adjustment

The standard EXJ Register LCD display is designed to be mounted at chest level or higher for proper viewing. The contrast of the display can be adjusted with a small screwdriver. The contrast adjustment is located at the top, right corner of the Display Board (See Figure 1). **A low mount view display is available upon request for mounting sites that are below chest level.**

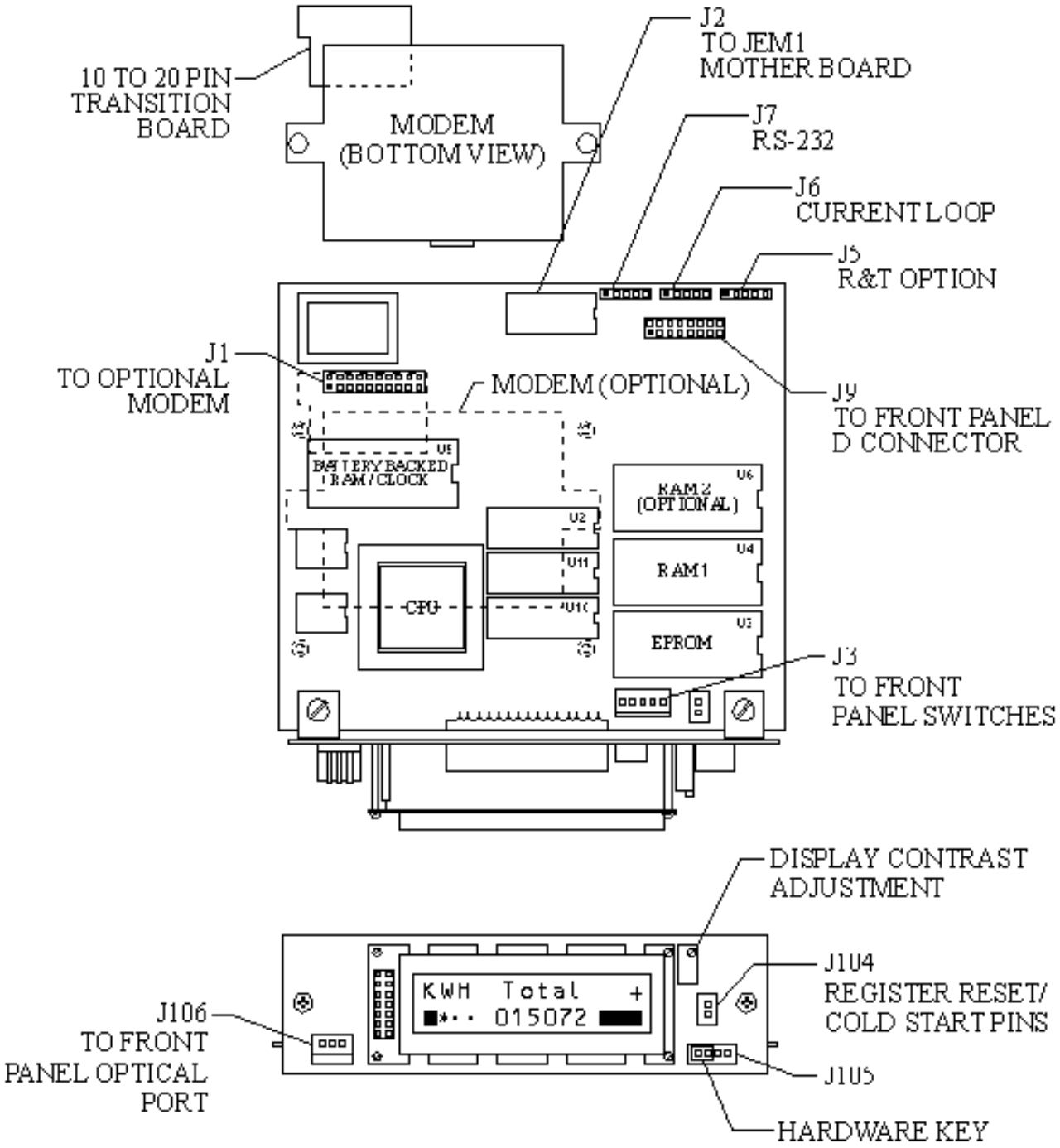


Figure 4-1 EXJ Register with Display and Optional Modem

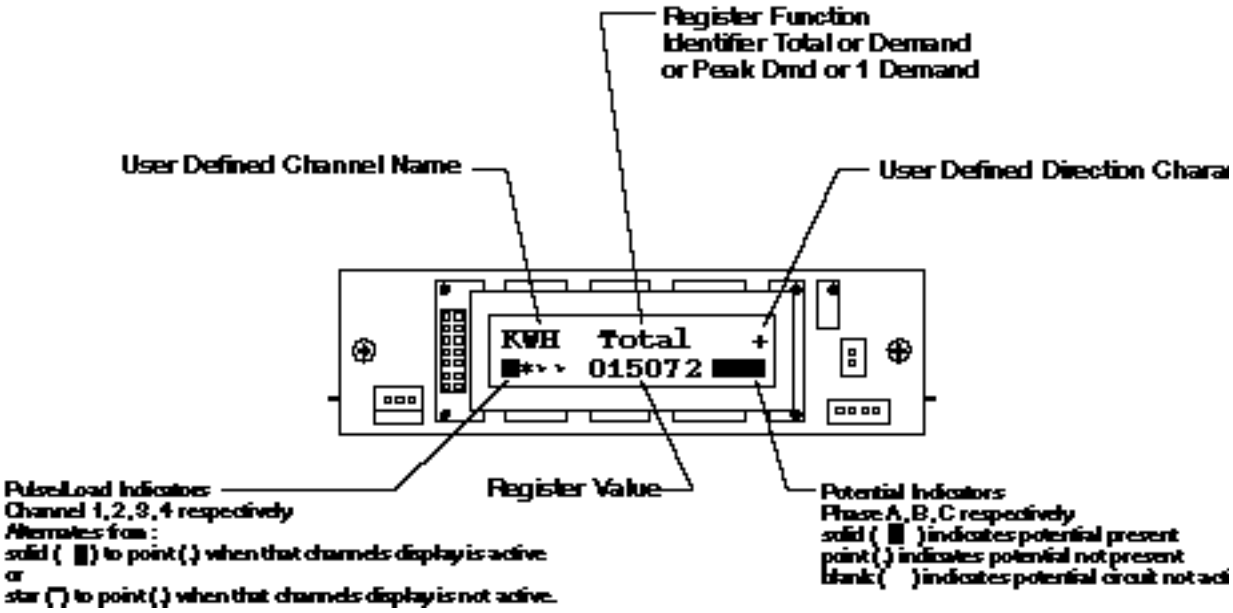


Figure 4-2 EXJ Active Display

Figure 4-3 EXJ Time of Peak Display

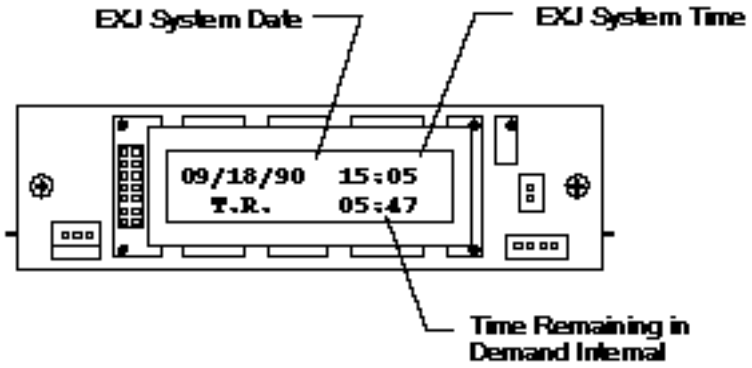


Figure 4-4 EXJ Clock Display

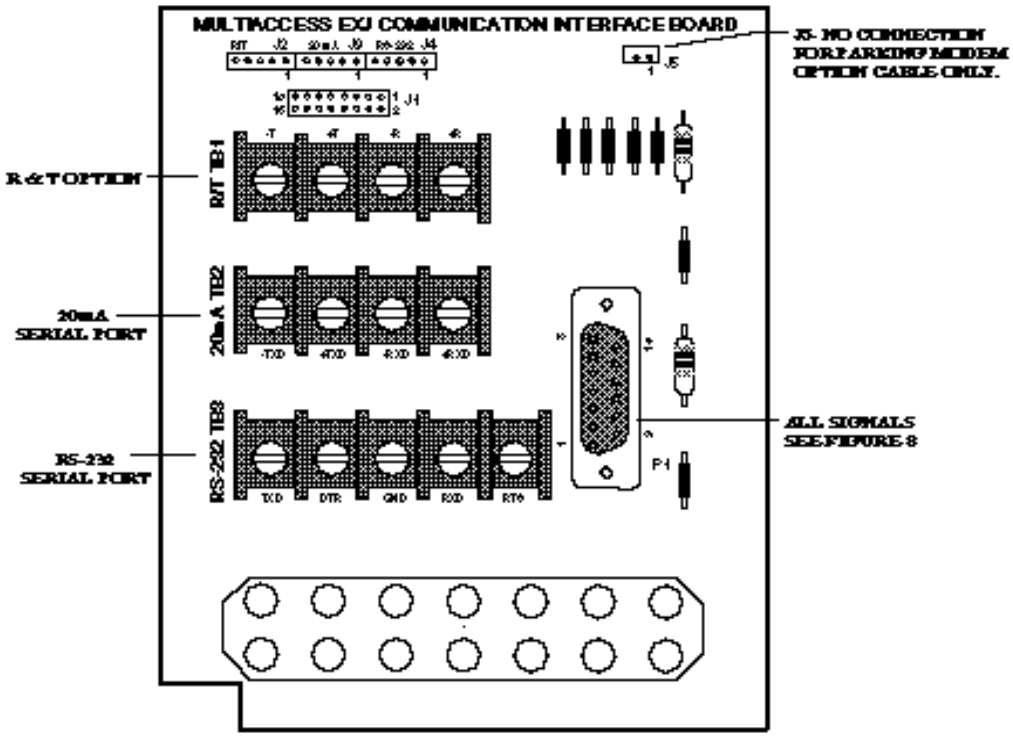


Figure 4-5 multi-access EXJ Communications Interface Board Supplied with Non-Modem Option

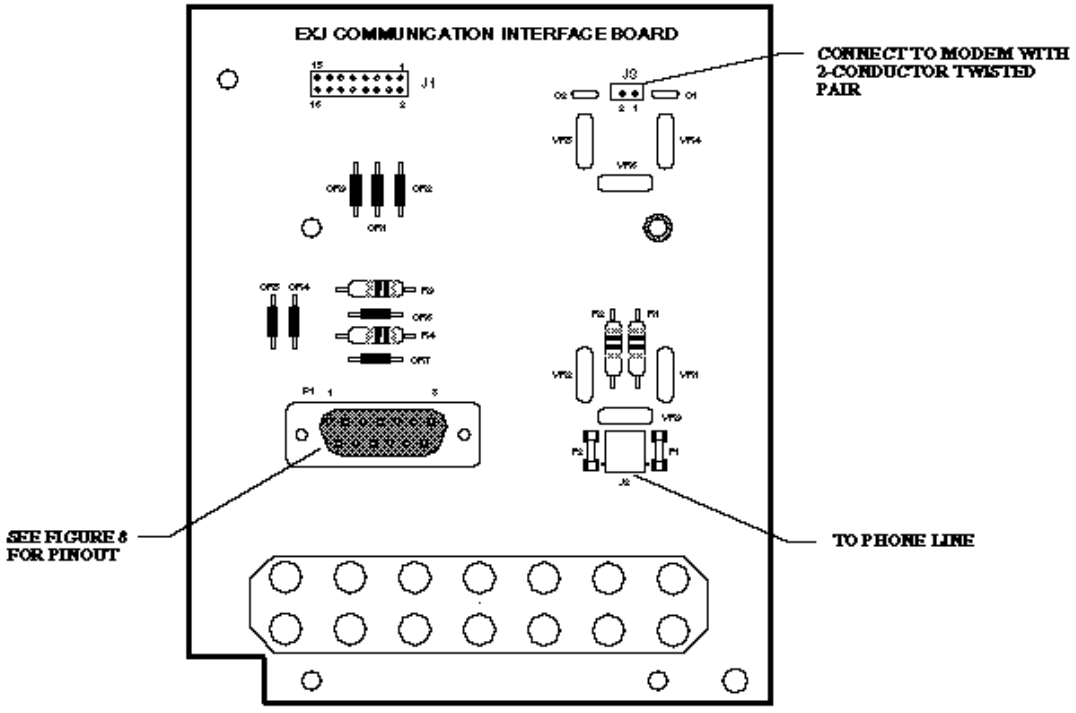


Figure 4-6 EXJ Communications Interface Board (Supplied with Modem Option)

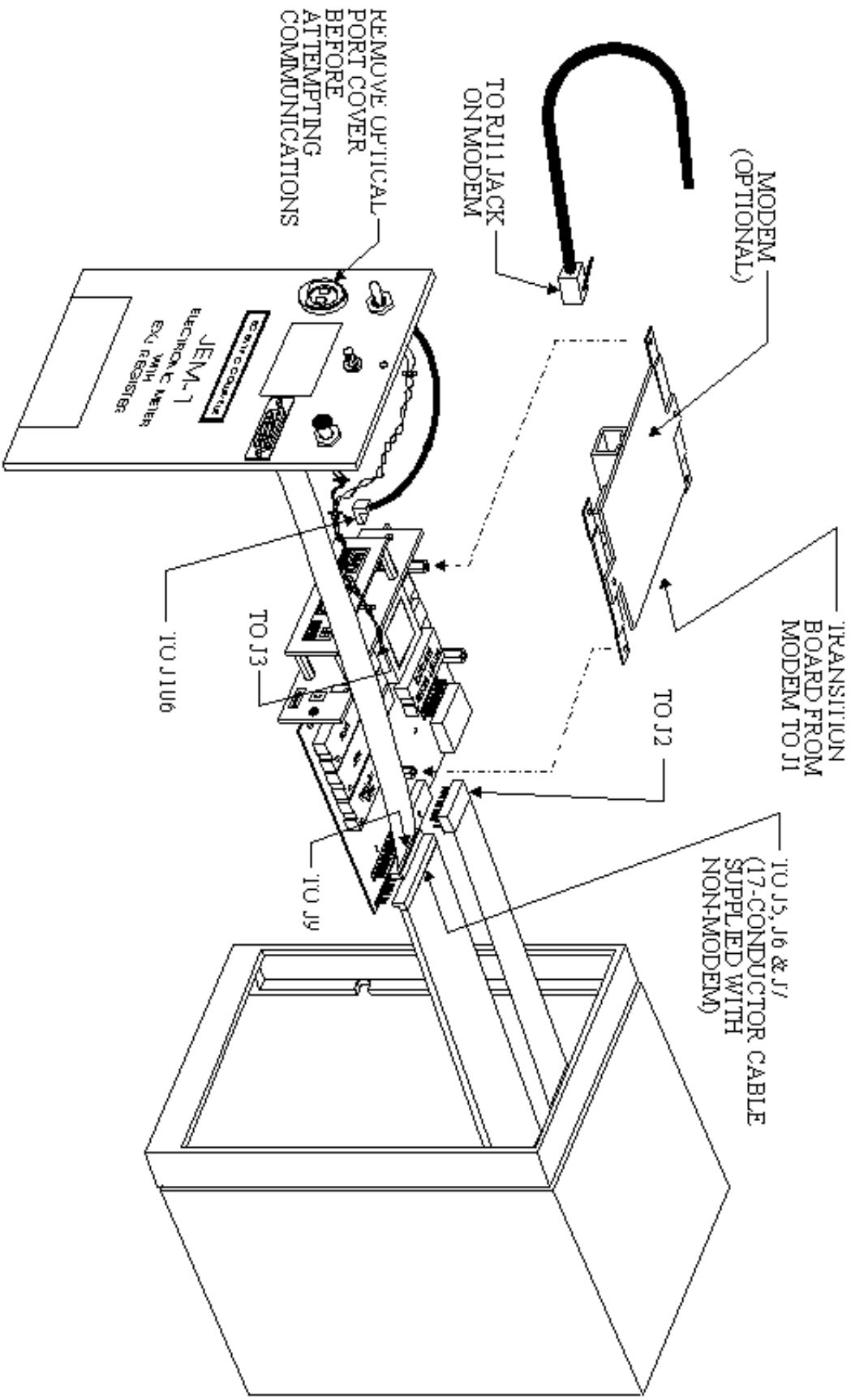


Figure 4-7 EXJ Communications Interface Board (Supplied with Modem Option)

4.3.3. EXJ™ Register 15-Pin "D" Connector Pinout

This 15-pin "D" connector may be used for serial communication. It is located on the Multi-access EXJ Communications Interface Board or the EXJ Communications Interface Board and the front panel of the JEM 1 (refer to Figures 5, 6, and 7).

PIN NUMBER	FUNCTION
1	No Connect
2	RTS (RS-232 Output)
3	TXD (RS-232) Output
4	-TXD Current Loop
5	+TXD Current Loop
6	-RXD Current Loop
7	+RXD Current Loop
8	No Connect
9	DTR (RS-232 Output)
10	GND (RS-232)
11	RXD (RS-232) Input
12	-End of Demand Interval Pulse
13	+End of Demand Interval Pulse
14	-R Option (20mA)
15	+R Option (20mA)

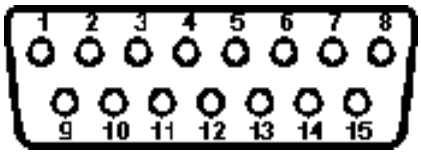


Figure 4-8 Male Pins Viewed Looking at the Connector

4.4. USING THE EXJ REGISTER

4.4.1. Register Reset

On the EXJ Register display board there are two pins on the right side of the display identified as J104 (see Figure 1). These pins are the **register reset/cold-start** terminals. Shorting these two pins together for a second or so induces a "register reset". The EXJ Register's **total consumption** registers, demands, and peak times are cleared, but the configuration values and real-time clock remain unaffected.

4.4.2. Cold start

> **CAUTION!**
> **A cold start will reset all configuration parameters to their default value.**

Shorting the J104 pins together for at least fifteen seconds will induce a "cold-start." All of the EXJ Registers are set to zero, and the configuration/communication parameters are set to their default values.

The display will read the following after performing a register reset / cold start:

REGISTER RESET	During first 15 seconds
RESET	After fifteen seconds
Configuration Checksum Failed	
Register Checksum Failed	Indicating a complete Cold Start
Chn 1 Total	All parameters set to defaults

4.4.3. Billing period reset

The RESET switch to the upper right of the faceplate causes a Billing Period Reset to be performed when pressed. The switch may be sealed by threading a seal wire or tab through the hole in the switch plunger. This reset causes the present Peak Demands to be added to the Cumulative Peak Demands of its respective channel, and the Peak Demands are reset to zero. Subsequent Billing Period Resets will be ignored for the remainder of the current (sub)interval, plus another whole (sub)interval. Pressing the RESET switch performs the same function as executing a valid Sx command.

4.4.4. Display Switch

The **DISPLAY** on the EXJ Register, and has three settings: ROLL, HEALTH CHECK, and an unmarked center position. When the **DISPLAY** switch is in its left-most position, the EXJ Register display is in ROLL mode. The display presents each EXJ Register function selected in the configuration for six seconds in cyclical order for each output channel:

1. **Total** units (consumption quantity).
2. **Demand** of last completed interval.
3. **Peak Dem**an**d**.
4. **Cum**ulative **Peak** demand.
5. **1**-minute **Demand**.
6. **Time** of **Peak** demand.
7. EXJ system clock and time remaining in the present demand interval. (This display shows only after all six items above are displayed for each channel)
8. If a particular function is not selected in the EXJ Register's configuration, the display skips that function.

Note:
You can quickly scroll though the register displays by toggling the switch from center to Roll.

The right-most position of the **DISPLAY** switch (labeled HEALTH CHECK) is a momentary setting. When the switch is held in the HEALTH CHECK position, the display presents a set of self-test and functional reports, at the same three-second rate the meter registers display. The health check displays:

1. EXJ Register system software version/revision number.
2. "ok / fail" for system RAM and ROM tests.
3. "ok / fail" for non-volatile RAM and backup battery.
4. Model number (as configured).

Note:
Any failure flags (items 2 and 3 above) can be cleared by performing a Billing Period Reset.

4.4.5. Communications

Communications may be established with the EXJ Register by either RS-232, current loop, optical port or through the optional modem. The details of the communications is described in the Serial Communications Section and Appendix IV of this manual. The location and pinout of these ports is shown in Figures 3, 4, 5 and 6.

4.4.6. Other input / output (R & T)

• EODIP (T-option): End of demand interval pulse.

The EODIP is a solid state, Form A output that closes for approximately one second at the end of each demand interval.

• "R-option": Time sync input is triggered by a 20mA input signal. This input will force the end of a demand interval if external demand timing is configured in the EXJ.

4.4.7. Hardware Key

The hardware key is a two pin jumper connecting pins 1 and 2 of connector J105 (see Figure 1 for location). If this jumper is not installed, then configuration commands are locked out, even with the activation of the correct password. See Figure 9 and Figure 19 for the commands that are hardware key protected.

4.4.8. Cold start values

1. Device address is set to 10.
2. Password is set to 000000.
3. The serial format is - 1200 baud, 8 data bits, no parity, 1 stop bit.
4. Auto print is off.
5. Clock is on.
6. Clock line sync is on.
7. Block check is off.
8. Register read reply like log is disabled.
9. Modem answer start time is 0000 (midnight).
10. Modem answer stop time is 1439 (11:59 PM).
11. Answer delay rings (modem) is set to 1.
12. External EODI is disabled.
13. Interval size is set to 15 minutes.
14. Subinterval size is set to 15 minutes.
15. Line frequency is 60 Hertz.
16. Count load rate 4 is disabled.
17. Calculate KVA from Q.
18. KVA reactive channel is 2.
19. Auto freeze at midnight is disabled.
20. Mass memory queue size is full size.
21. Log format is set to the following:
    "CL1'Unit 'AS3'JEM®1'S3DS3I' Minute Demand 'W' Minute Window'CLZRCLE"
22. The binary read response is set as follows:
    Default Binary Read Response:

Channel 1	Total Register
Channel 1	Peak Demand Register
Channel 1	Time of Peak Register
Channel 2	Total Register
Channel 2	Peak Demand Register
Channel 2	Time of Peak Register
Channel 3	Total Register
Channel 3	Demand Register
Channel 4	Total Register
Channel 5	Total Register
Channel 1	Total Register
Channel 1	Peak Demand Register
Channel 1	Time of Peak Register
Channel 2	Total Register
Channel 2	Peak Demand Register
Channel 2	Time of Peak Register
Channel 3	Total Register
Channel 3	Demand Register
Channel 4	Total Register
Channel 5	Total Register

23. The RTS to TXD delay and the TXD to RTS delay is set to zero line cycles.
24. The DTR pulse width is set to 5 line cycles.

4.5. DISPLAY QUANTITIES ON THE EXJ REGISTER

The register display is a cyclical sequence of the enabled display quantities. The register is designed to accommodate a variety of meter configurations with up to 30 displayable quantities. Most meters will not use all of these quantities and are configured to select the desired quantities for a particular meter as needed. The configuration is accomplished by "programming" with the serial interface command messages. Meters are configured at the factory to settings designated by the user where possible. If not provided with user values, then appropriate typical selections will be made. Performing a "cold-start" or initializing the meter will clear all programmed parameters to the default condition.

EXJSET, a configuration and data base software system, is available for programming the EXJ Register. The program is designed to run on any PC/PC-compatible computer.

The JEM series meters are secondary rated meters that are normally used with external voltage and current transformers. The units of registration are not necessarily the labeled quantities unless the meter is calibrated and programmed properly for the external ratios.

The EXJ Register offers a great degree of flexibility with a register divisor range of 1 to 9999 and a displayable decimal point in any position.

Note that the **divisor affects only total quantities and not demand readings.**

The decimal point selection is user defined; that is, it is used to clarify the display, but does not alter the display resolution.

4.6. USING THE REGISTER DIVISOR

4.6.1. Example:

Let us examine a hypothetical JEM 1/EXJ Register, with 600:5 current transformers and 4,200:120 potential transformers. One desired display is a six digit megawatt hour readout with a resolution of 0.1 megawatt hour.

Beginning with the input transformers, we see there is a 4,200:1 ratio between primary power and secondary power.

$$CTR \times PTR = \frac{600}{5} \times \frac{4,200}{120} = 35 \times 120 = 4,200$$

This 4,200:1 ratio is not divisible by an integer number to yield a direct output of primary power for the EXJ Register's display. Hence, the secondary pulse constant (K_e) of the JEM 1 must be set through hardware to provide the needed calibration. With a goal of 1 kWh of primary power per pulse to the EXJ Register, we see that there must be a secondary K_e of 0.2381 Wh/pulse:

$$Pk_e = \frac{VTR \text{ x } CTR \text{ x } K_e}{1000} = \frac{35 \text{ x } 120 \text{ x } 0.2381}{1000} = 1.0 \text{ kWh}$$

This pulse is then fed into the EXJ Register. However, the count rate is still too fast to meet the registration needed for the desired display output. Hence, we may set the EXJ Register's **display divisor** to obtain the desired registration. For a display registration of 0.1 MWh/count and an input of 1 kWh/pulse, the divisor would be 100.

$$\mathrm{Pk_r(kWh / digit)} = Pk_e \times \mathrm{R_d} = 1\mathrm{kWh} \times 100 = 1.0\mathrm{kWh\ digit}$$

With the divisor entered, the EXJ Register watthour consumption register is set for 5 digits before the decimal point, and named "MWh +"

NOTE:
Please refer to Section 3 for specific information about function and integrator K_e board settings.

4.7. SERIAL COMMUNICATIONS

Among the greatest advantages of using the EXJ Register are the flexibility and range of information available to the user through the serial ports. The EXJ Register actually has only one serial port, imbedded in its central processor. This port is serviced by three hardware interfaces: optical, current loop, and RS-232C/V.24-compatible. Any one of these ports may be used to communicate with the EXJ Register at any time, although only one port at a time may be used.

There are two serial protocols available to the user of the EXJ Register; **ASCII** and **binary**. The "ASCII" (American Standard Code for Information Interchange) protocol is a **textual based** system, similar to the protocols for the JEM 2 and other SCIENTIFIC COLUMBUS systems. The ASCII protocol offers the advantage of a "human-readable" response from the EXJ Register, so that even a user with only a terminal and a modem may communicate with the EXJ Register. A disadvantage of the ASCII protocol is the length of transmissions when large data fields are being retrieved, making communications both more time-consuming and more expensive.

The binary protocol is a **numerically based** system which transfers data in a compressed binary form. This system works best in situations where large bodies of data must be transferred in a short time, and a host computer is normally used to process the data into a final form. The main disadvantage of the binary protocol is that the data received are not easily "human-readable." Typically, binary protocol users will interrogate their units from a host computer, using the SCIENTIFIC COLUMBUS JART® or JAV® systems, or from a SCIENTIFIC COLUMBUS RHC-88-portable computer, using the MicroJART® software system.

The EXJ Register is bilingual. The Register parses a message as if the message is under ASCII Protocol; the Register also parses the message as if it is under Binary Protocol. The Register ignores any message that is not satisfactorily and correctly parsed under either ASCII or BINARY Protocol.

4.8. ASCII COMMAND FORMAT

All of the commands in the EXJ Register ASCII protocol share the same fundamental structure. These commands are built of the following components:

1. An ASCII SOH "Start-of-Heading" character.
2. A two-character "Device Address."
3. A two-character "Command String."
4. An ASCII STX "Start-of-Text" character (if required).
5. A "Text/Data Block" (if required).
6. An ASCII ETX "End-of-Test" character (if required).
7. A linear-redundancy (Block-Check) test character.

4.8.1. Start of Header (SOH)

The SOH character (hexadecimal 01) marks the beginning of all EXJ Register ASCII commands. This character is usually entered on a computer or terminal as a "Control-A" (i.e., holding down the CTRL key and pressing "A").

4.8.2. Device Address (HOA, LOA)

As with other SCIENTIFIC COLUMBUS serial port equipped products, the EXJ Register may be identified by the user with a two-character address. The first, or "high-order" address character (HOA) and the second or "low-order" address character (LOA) must be a hexadecimal number (0 through 9). The address is selected by the user when configuring the EXJ Register.

Two addresses, FE and 00, are reserved for special use and should not be assigned to an EXJ Register.

FE is a universal address. An EXJ Register will perform and respond appropriately to the command as if you used its correctly assigned address. 00 is a universal broadcast address in which an EXJ Register will perform appropriately to the command, but will not respond back. This address is useful when executing a FREEZE simultaneously to all registers in a network, to keep the registers form trying to respond simultaneously.

4.8.3. Command String

The command string is a two-character command identifier. All of the commands in the EXJ Register ASCII command set are upper/lower case sensitive. Refer to the command list for the proper format.

4.8.4. Start of Text (STX)

The STX character (hexadecimal 02) marks the beginning of text strings or data. This character is usually entered on a computer or terminal as a "Control B" (i.e., holding down the CTRL key and pressing "B").

4.8.5. Text/Data Block

This block contains any required text strings or data.

4.8.6. End of Text (ETX)

The ETX character (hexadecimal 03) marks the end-of-test string or data. This character is usually entered on a computer or terminal as a "Control C" (i.e., holding down the CTRL key and pressing "C").

4.8.7. Block Check (BCC)

As a means of insuring serial data integrity, the ASCII commands processed by the EXJ Register are checked through a linear redundancy test. Beginning with the character following the SOH, each character is exclusive OR'd with the one following. The result is appended to the end of the command. Refer to Appendix II for calculating Block Check.

NOTE:
Although the block-check test for received commands may be deleted by the user during configuration, it is recommended that both transmitted and received data be block check tested to maintain data integrity.

4.8.8. Response

When the correct unit address of the EXJ Register is used in a command, the response will be as described under each command description. If a command is sent and a response is not expected back, such as FREEZE, then the unit will respond with an ASCII ACK (acknowledge) character. Attempting to perform a protected command without first activating the PASSWORD will result in an ASCII NAK (negative acknowledge) being returned as soon as the command is decoded. NAK may also be sent when attempting to program the meter with illegal values.

Refer to the address description for the response when using address 00 or FE.

4.8.9. ASCII COMMAND SUMMARY

Each command in the EXJ ASCII Protocol is represented by a two-character command string. All commands in the EXJ Register ASCII command set are case sensitive. **BE SURE TO USE THE CORRECT CASE WHEN SENDING COMMANDS**.

COMMAND	PWD REQ	KEY REQ	FUNCTION
AD	√	√	Set address
AP	√	√	Set auto-print
†Bx	√		Force serial end-of-demand interval (EODI)
CF	√	√	Set line frequency
CK	√	√	Clock on/off
CL	√	√	Clock line synchronization
cm	√	√	Configure miscellaneous
CS	√	√	Set serial parameters
ct	√	√	Configure timing of RTS & DTR signals
DF	√		Download format table
DI	√	√	Set demand interval/subinterval
DP/dp	√	√	Set display decimal points
DR	√	√	Set register directions
DS	√	√	Select displayed registers
DV	√	√	Set pulse divisors
EB	√	√	Enable block-check
EM	√	√	Erase mass memory
†Fx			Freeze registers
HC			Health check
†Lx			Log registers
ME	√	√	Modem on/off
MS	√	√	Model Set
NA	√	√	Name display registers
PA			Password activate
PC	√	√	Password change
PD			Password deactivate
PR	√	√	Preset registers
QM			Query Model
QT	√		Query type
†Rx			Read registers
†Sx	√		Billing period reset
sr	√	√	Set binary read
TS	√	√	Set clock
UF	√	√	Upload format table
VM	√		Verify miscellaneous
VV	√		Verify divisors
ZZ	√	√	Hibernate

†The character x can be any upper case letter.
PWD REQ means that the Password is required to perform command.
KEY REQ means that the hardware key is required to perform command.

Figure 4-1 ASCII Command Table

4.8.10. ASCII COMMAND SET

The command strings used in the ASCII Protocol are all very similar in structure. The beginning three characters and the ending character are identical for each command string. The initial character is the Start-of Header (SOH). The next two characters are the High Order Address (HOA) and the Low Order Address (LOA) of the EXJ Register. Characters four and five always define which command is being sent. Beginning with character six is the text portion of the command string. This text portion is not in a standard format and may be different from one command to another and in some cases may not even exist. The last character of every command string is the Block Check Character (BCC).

In this document, each command string is illustrated as a string of boxes where each box represents one character. The characters in ***bold italics*** should be keyed in as written. The characters in normal type face represent variables (see each command for more information).

The SOH, STX, and ETX characters are keyed in as Control A, Control B, and Control C respectively. The BCC character can be any ASCII character (see the ASCII COMMAND FORMAT section for more information).

AD - Set Address

This command redefines the EXJ Register's device address.

SOH	HOA	LOA	A	D	STX	HON	LON	ETX	BCC

"HON" and "LON" are the new "high-order" and "low-order" address characters, respectively.

AP - Set Auto-Print

This command turns the EXJ Register's "auto-print" feature on or off. The "auto-print" function transmits a register reading from the serial port automatically at the end of each demand interval.

SOH	HOA	LOA	A	***P***	STX	J	ETX	BCC

where: J = 1 turns the function on;

J = 0 turns it off.

Bx - Force End-of-Demand Interval

This command will force an end of demand interval (EODI) if the external EODI input is enabled (see the 'H' field in cm command).

SOH	HOA	LOA	***B***	***x***	BCC

The character x can be any upper case letter.

CF - Set Line Frequency

The EXJ Register monitors the AC line frequency to aid in phase related calculations and (if configured) real-time clock regulation. This command specifies the AC line frequency.

Y	HOA	LOA	***C***	***F***	STX	J	ETX	BCC

where: J = 1 sets 50 Hz;

J = 0 sets 60 Hz.

CK - Clock On/Off

This command activates and deactivates the EXJ Register's real-time clock.

SOH	HOA	LOA	***C***	***K***	STX	J	ETX	BCC

where: J = 1 turns clock on;

J = 0 turns it off.

CL - Clock Line Synchronization

This command determines the synchronization source for the EXJ Register's real-time clock.

SOH	HOA	LOA	***C***	***L***	STX	J	ETX	BCC

where: J = 1 synchronizes the clock to the AC line;

J = 0 lets the clock run on its own crystal-controlled time base.

cm - Configure Miscellaneous

Several items are configured with this command. All values must be entered. See below for a complete list:

SOH	HOA	LOA	***c***	***m***	STX	A	B	C	C
C	C	D	D	D	D	E	F	G	G
G	G	H	I	J	K	L	M	M	M
M	M	N	P	P	P	P	P	ETX	BCC

where:

A Source of kVA Calculation -
A="1"-Q A="0"-Vars

B Channel Used for kVA Calculation -
values "0"-"3" for channels 1 through 4.

CCCC Answer Start Time (Modem) -
decimal "0000" through "1439" for minute of the day.

DDDD Answer Stop Time (Modem) -
decimal "0000" through "1439" for minute of the day.

E Answer Delay Rings (Modem) -
values are special ASCII representations (See Figure 8.)

F Modem Type -
"1" - Bell type "0" - CCITT type,
currently only Bell supported.

GGGG Communications Time-out -
decimal seconds
Example: "0010" - 10 second time-out.
Range - "0000" - "0600".

H External EODI "R" Pulse Input -
"1" - enabled "0" - disabled.

I Register Read Reply Like Log -
"1" - enabled "0" - disabled.

J Auto-Freeze at Midnight -
"1" - enabled "0" - disabled.

K Number of Mass Memory Channels Stored -
"0" - disable mass memory "1" - "5" number of channels stored.

L Mass Memory Interval Length -
L can have values 1-60 where: 60/L = integer -
values are special ASCII representations.

MMMMM Mass Memory Channel Assignments -
All five (5) characters must be specified no matter how many channels were selected with K above. Five mass memory channels are available. Each character corresponds to a MM channel
1 character --- 1st channel
2 character --- 2nd channel
M - may have the values 1 - 5 which correspond to EXJ Register channels 1-5.

N Daylight Savings Time
"1" - Enable "0" - Disable

PPPPP Maximum mass memory queue size
(00000-65535).

Figure 4-1 Special ASCII Chart

CS - Set Serial Parameters

This command sets the transmission speed and data format of the serial port.

SOH	HOA	LOA	***C***	***S***	STX	B	P	ETX	BCC

The data field "BP" is a two-digit representation of the baud rate, parity, and bit structure. All formats use 1 stop bit.

"**B**" - Baud rate -- 0 = 300 baud.
1 = 600 baud.
2 = 1,200 baud.

"**P**" - Parity and bit structure --
0 = No Parity/8 data bits.
1 = Even parity/7 data bits.
2 = Odd parity/7 data bits.

ct - Configure Timing of RTS and DTR Signals

This command configures the timing of the RTS timing delays (reference Figure 11) and the DTR pulse width. The DTR signal is normally asserted following a power on initialization. Following a communication time-out, DTR is negated for a configurable time of zero to 255 line cycles, then re-asserted.

SOH	HOA	LOA	***c***	***t***	STX	J	J	J	K
K	K	L	L	L	ETX	BCC			

where:

JJJ is the RTS-to-TXD
(T1 in Figure 11)
values of 000 to 255 line cycles

KKK is the TXD-to-RTS delay (T2 in Figure 11)
values of 000 to 255 line cycles

LLL is the DTR pulse width
values of 000 to 255 line cycles

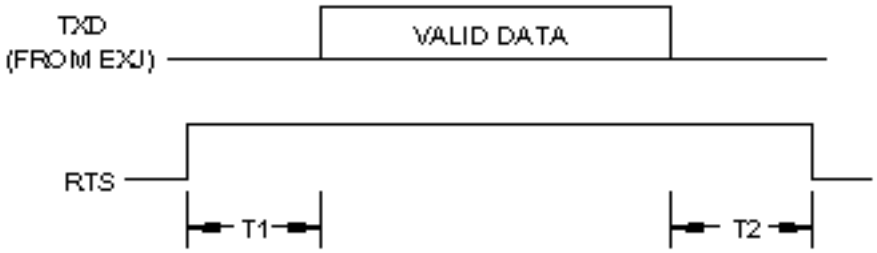


Figure 4-2 RTS Timing Diagram

DF - Download Log Format

Download log format causes the currently defined log format string to be returned. Also see Lx and UF commands.

SOH	HOA	LOA	***D***	***F***	BCC

DI - Set Demand Interval/Subinterval

This command determines the length of demand intervals and subintervals in the EXJ Register.

SOH	HOA	LOA	**D**	**I**	STX	I	I	S	S
ETX	BCC								

The data field "IISS" represents the demand interval and subinterval lengths as two, two-digit decimal numbers, with leading zeros for numbers less than 10. For example, using a 30-minute interval with six 5-minute subintervals would yield a data entry of "3005". SS must be "00" for block intervals.

NOTE:
The EXJ Register cannot accept more than fifteen (15) subintervals per interval.

DP/dp - Set Display Decimal Points

There are **two** commands in this function, differentiated by the upper/lower case of the command string. The first, sent in **uppercase**, sets the decimal point values for the **total consumption and demand registers only**.

SOH	HOA	LOA	D	P	STX	D	D	D	D
D	ETX	BCC							

The data field "DDDDD" contains the number of digits **to the left** of the decimal point for <u>all</u> the registers of each channel.

Digit	Display
0	**.**######
1	#**.**#####
2	##**.**####
3	###**.**###
4	####**.**##
5	#####**.**#
6	######

The second command, sent in lowercase, sets the decimal point placement for **all** registers independently.

SOH	HOA	LOA	d	p	STX	T	D	P	C
M	T	D	P	C	M	T	D	P	C
M	T	D	P	C	M	T	D	P	C
M	ETX	BCC							

The data field here is five, 5-digit fields, representing the decimal point values for the **T**otal, **D**emand, **P**eak Demand, **C**umulative Demand and 1-**M**inute Demand. The format is the same as in the uppercase form.

DR - Set Register Directions

This command sets the display indicator for the direction of power through the JEM 1 (delivered, received, or non-directional) for each display channel.

SOH	HOA	LOA	***D***	***R***	STX	D	D	D	D
D	ETX	BCC							

The text field "DDDDD" contains the direction symbols of channels 1 through 5:

For example:

"D" = Delivered.

"R" = Received.

DS - Select Displayed Registers

This command determines which register channels are to be displayed by the EXJ Register. The channel assignments **must match** the function and/or integrator boards installed in the JEM 1 meter.

SOH	HOA	LOA	***D***	***S***	STX	T	D	P	C
M	O	T	D	P	C	M	O	T	D
P	C	M	O	T	D	P	C	M	O
T	D	P	C	M	O	ETX	BCC		

The data field is actually a set of five 6-digit fields, with each field representing the register functions within each channel: **T**otal, **D**emand, **P**eak Demand, **C**umulative Demand, One-**M**inute Demand and Time-**O**f-Peak-Demand. Each entry is set to either a "1" to display the register, or set to a "0" to suppress the display.

DV - Set Pulse Divisors

This command accepts the divisor constants used to calculate the displayed total register values from the JEM 1's pulse outputs.

SOH	HOA	LOA	***D***	***V***	STX	X	X	X	X
X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	ETX	BCC		

The data field in this command is five, 4-digit decimal numbers with leading zeros, one field for each EXJ Register total register channel. The divisors may range from "0001" to "9999." **Every channel** in the EXJ Register **must** have a divisor, whether active or not.

EB - Enable Block-Check

This command determines whether or not incoming serial commands are tested for their proper "block-check" character. If the user configures the EXJ Register to **ignore** "block check," any ASCII character may be used at the end of a command. The EXJ Register **always** performs "block-checking" on outgoing serial data.

SOH	HOA	LOA	***E***	***B***	STX	J	ETX	BCC

where:

J = 1 enables block-check;

J = 0 disables block-check.

EM - Erase Mass Memory

This command will completely erase mass memory.

SOH	HOA	LOA	***E***	***M***	STX	ETX	BCC

Fx - Freeze Registers

The FREEZE command records an instantaneous image of all the EXJ Register's total, demand, and time registers in a data buffer. This buffer may be read back non-destructively with the READ or LOG commands. The "frozen" data remain undisturbed until another FREEZE is sent. The FREEZE command is structured as follows:

SOH	HOA	LOA	***F***	***x***	BCC

HC - Health Check

Aside from the data available via the display, there is a serial "health check" command in the EXJ Register. The command is formatted as follows:

SOH	HOA	LOA	***H***	***C***	BCC

The EXJ Register returns the "health check" in textual form:

HEALTH CHECK RESPONSE

Notes:

1. indicates a carriage return and line feed, and note that all lines are delimited with a carriage return and line feed.
2. Numbers on left edge are reference line numbers only, and numbers at top and bottom are reference column numbers only.
3. Lines 1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 14, 15 and 20 are always fixed in length, all other lines are not.

4.9. RESPONSE OF READ REGISTER COMMAND:

There are two types of responses which may be returned after issuing this command. The two responses are the **Like Log** and **Standard** response.

Like Log

The **Like Log** response will be returned if the EXJ Register was configured for this response with the CM command. This response will be exactly the same as the response from the LOG command.

Standard

The **Standard** response from the Read Register command is a string of ASCII characters (integer numbers) with the format:

HOA	LOA	M	x	(see tables)	ETX	BCC

where: x is the Freeze sequence. (A - Z)

Position(s)	# of	Description
1 thru 6	6	Chn 1 Total Consumption
7 thru 12	6	Chn 1 Demand
13 thru 18	6	Chn 1 Peak Demand
19 thru 24	6	Chn 1 Cumulative Peak Demand
25 thru 30	6	Chn 1 Minute Demand
31 thru 36	6	Chn 2 Total Consumption
37 thru 42	6	Chn 2 Demand
43 thru 48	6	Chn 2 Peak Demand
49 thru 54	6	Chn 2 Cumulative Peak Demand
55 thru 60	6	Chn 2 Minute Demand
61 thru 66	6	Chn 3 Total Consumption
67 thru 72	6	Chn 3 Demand
73 thru 78	6	Chn 3 Peak Demand
79 thru 84	6	Chn 3 Cumulative Peak Demand
85 thru 90	6	Chn 3 Minute Demand
91 thru 96	6	Chn 4 Total Consumption
97 thru 102	6	Chn 4 Demand
103 thru 108	6	Chn 4 Peak Demand
109 thru 114	6	Chn 4 Cumulative Peak Demand
115 thru 120	6	Chn 4 Minute Demand
121 thru 126	6	Chn 5 Total Consumption
127 thru 132	6	Chn 5 Demand
133 thru 138	6	Chn 5 Peak Demand
139 thru 144	6	Chn 5 Cumulative Peak Demand
145 thru 150	6	Chn 5 Minute Demand
151, 152	2	Month of Register Freeze
153, 154	2	Date of Freeze
155, 156	2	Year of Freeze
157, 158	2	Hour of Freeze
159, 160	2	Minute of Freeze
161	1	Day of week of Freeze
162, 163	2	Chn 1 Peak Demand Month of
164, 165	2	Chn 1 Peak Demand Date of
166, 167	2	Chn 1 Peak Demand Year of
168, 169	2	Chn 1 Peak Demand Hour of
170, 171	2	Chn 1 Peak Demand Minute of
172	1	Chn 1 Peak Demand Day of week of
173, 174	2	Chn 2 Peak Demand Month of
175, 176	2	Chn 2 Peak Demand Date of
177, 178	2	Chn 2 Peak Demand Year of
179, 180	2	Chn 2 Peak Demand Hour of
181, 182	2	Chn 2 Peak Demand Minute of
183	1	Chn 2 Peak Demand Day of week of
184, 185	2	Chn 3 Peak Demand Month of
186, 187	2	Chn 3 Peak Demand Date of
188, 189	2	Chn 3 Peak Demand Year of
190, 191	2	Chn 3 Peak Demand Hour of
192, 193	2	Chn 3 Peak Demand Minute of
194	1	Chn 3 Peak Demand Day of week of
195, 196	2	Chn 4 Peak Demand Month of
197, 198	2	Chn 4 Peak Demand Date of
199, 200	2	Chn 4 Peak Demand Year of
201, 202	2	Chn 4 Peak Demand Hour of
203, 204	2	Chn 4 Peak Demand Minute of
205	1	Chn 4 Peak Demand Day of week of
206, 207	2	Chn 5 Peak Demand Month of
208, 209	2	Chn 5 Peak Demand Date of
210, 211	2	Chn 5 Peak Demand Year of
212, 213	2	Chn 5 Peak Demand Hour of
214, 215	2	Chn 5 Peak Demand Minute of
216	1	Chn 5 Peak Demand Day of week of
217, 218	2	Demand Int. Remaining Time Minutes
219, 220	2	Demand Int. Remaining Time Seconds
221, 222	2	Interval Size
223, 224	2	Sub-Interval Size

Read Response Table with Clock Enabled

Character		
Postion	**# of**	**Description**
1 thru 6	6	Chn 1 Total Consumption
7 thru 12	6	Chn 1 Demand
13 thru 18	6	Chn 1 Peak Demand
19 thru 24	6	Chn 1 Cumulative Peak Demand
25 thru 30	6	Chn 1 Minute Demand
31 thru 36	6	Chn 2 Total Consumption
37 thru 42	6	Chn 2 Demand
43 thru 48	6	Chn 2 Peak Demand
49 thru 54	6	Chn 2 Cumulative Peak Demand
55 thru 60	6	Chn 2 Minute Demand
61 thru 66	6	Chn 3 Total Consumption
67 thru 72	6	Chn 3 Demand
73 thru 78	6	Chn 3 Peak Demand
79 thru 84	6	Chn 3 Cumulative Peak Demand
85 thru 90	6	Chn 3 Minute Demand
91 thru 96	6	Chn 4 Total Consumption
97 thru 102	6	Chn 4 Demand
103 thru 108	6	Chn 4 Peak Demand
109 thru 114	6	Chn 4 Cumulative Peak Demand
115 thru 120	6	Chn 4 Minute Demand
121 thru 126	6	Chn 5 Total Consumption
127 thru 132	6	Chn 5 Demand
1133 thru 138	6	Chn 5 Peak Demand
139 thru 144	6	Chn 5 Cumulative Peak Demand
145 thru 150	6	Chn 5 Minute Demand
151 thru 161	11	00000000000
162, 163	2	Demand Int. Remaining Time Minutes
164, 165	2	Demand Int. Remaining Time Seconds
166, 167	2	Interval Size
168, 169	2	Sub-Interval Size

Read Response Table with Clock Disabled

Sx - Billing Period Reset

This protected data command performs the same function as pressing the RESET switch on the EXJ Register's faceplate. It is formatted as follows:

SOH	HOA	LOA	***S***	***x***	BCC

The EXJ Register performs the reset immediately, and returns an ASCII ACK character if the correct device address was sent. Subsequent Billing Period Resets will be ignored for the remainder of the current (sub)interval, plus another whole (sub)interval.

sr - Set Binary Read

When using the EXJ Register binary protocol that emulates JEM®2 binary commands, groups of registers may be **selected** for transmission in answer to a READ command from the host system. This register read is formatted by the SET BINARY READ command.

SOH	HOA	LOA	***s***	***r***	STX	C	R	C	R
C	R	C	R	C	R	C	R	C	R
C	R	C	R	C	R	C	R	C	R
C	R	C	R	C	R	C	R	C	R
C	R	C	R	C	R	ETX	BCC		

The data field is a set of twenty coordinate fields of two characters each.
The entries are made as follows:

Channel Number >> C R << Register Number 1 through 5

1 Total consumption.
2 Demand of last completed interval.
3 Peak demand.
4 Cumulative demand.
5 1-minute demand.
6 Time-of-peak demand

NOTE:
All twenty coordinate pairs in the SET BINARY READ command MUST be set to a valid, in-use channel and register.

TS - Set Clock

This protected data command allows coordination of the EXJ Register's real-time clock with another time source.

SOH	HOA	LOA	***T***	***S***	STX	M	M	D	D
Y	Y	H	H	M	M	DOW	ETX	BCC	

"MMDDYYHHMM" is a numeric field, containing the month, day, year, hours and minutes in two-digit decimal form.
“DOW" is the numeric day-of-the-week, where
Sunday = 1 and Saturday = 7.
Seconds may be synchronized by transmitting the block-check character precisely at zero seconds of the set time.

UF - Upload Format

Upload format command is used to define a special response to the log command. Also see DF and Lx commands.

SOH	HOA	LOA	***U***	***F***	STX	T...	E	ETX	BCC

The upload format command string contains the format table in the text portion of the message. Combinations of the following characters are used in place of T as required to define the desired response:

Sx Prints spaces, where x = 1 - 9.

' Prints all text between two single quotes ('TEXT').

Vcr Register value, where c is channel number (1 through 5) and r (1 through 6) selects one of the six readings associated with each channel; e.g., V13 causes peak demand of channel 1 to be sent.

1 New billing period flag (=). Prints flag(=) if a billing period reset occurred since the last freeze command was received. Otherwise, prints a space.

2x New peak flag (*), x is channel selection (1 through 5). Prints flag(*) if a demand peak occurred since the last freeze command was received. Otherwise, prints a space.

L Line feed.

C Carriage return.

D Date and time. Format is "MM/DD/YY HH:MM:SS" or "No Clock" if clock is disabled.

B BCC character.

R Time remaining in demand interval.

I Value of demand interval.

\XXX Start of literal prints ASCII character of the decimal value. Exceptions: (1) \254 prints the x character from the last Freeze command (Fx). (2) \253 is a sequence character, which is an ASCII character ranging from "A" to "Z" that is incremented to the next character by the Freeze command (Note: the character that follows "Z" is "A").

W Subinterval value.

Z Standard format (all registers).

E End of table marker (must be last text character).

A Unit Address

The default log format string contains all possible register, demand, and time values and generates the following typical outputs, after an Lx command:

When the clock is enabled:

When the clock is disabled:

Notes:

1. ¶ indicates a carriage return and line feed, and note that all lines are delimited with a carriage return and line feed.
2. Numbers on left edge are reference line numbers only, and numbers at top and bottom are reference column numbers only.
3. Columns 24 of lines 5 through 9 show where the new peak flag will print out.
4. All dates display or print out formatted as month/day/year.

The default log format string is:

where:

	Response Starts at			
	Clock Enabled		Clock Disabled	
	line	column	line	column
	1	1	1	1
	2	1	2	1
	2	2	2	2
	2	7	2	7
	2	9	2	9
	2	12	2	12
	2	17	2	17
	2	20	2	20
	2	37	2	29
	2	40	2	32
	2	43	2	35
	2	58	2	50
	2	61	2	53
	2	74	2	66
	3	1	3	1
	10	1	10	1
	10	17	10	17
	End of table marker			

VM - Verify Miscellaneous

This command returns the current values which are configurable with the Configure Miscellaneous command. Also see the cm command.

SOH	HOA	LOA	***V***	***M***	STX	ETX	BCC

Response from VM command:

SOH	HOA	LOA	V	M	STX	$	$	$	space
A	A	B	B	space	C	C	D	E	F
space	G	H	space	I	J	K	L	space	M
N	space	P	P	P	P	P	space	Q	Q
Q	Q	Q	space	R	R	R	R	R	space
S	T	U	V	W	X	Y	Y	Y	Y
Y	Z	#	#	#	#	#	ETX	BCC	

where:

$$$ Model

AA Interval Size

BB Subinterval Size

CC EXJ ™ Register Address

D Baud Rate - 0 = 300 1 = 600 2 = 1200

E Parity/Data Bits/Stop Bits
(0 = N,8,1 1 = E,7,1 2 = 0,7,1)

F BCC Enable 1 = Enabled 0 = Disabled

G Auto Print 1 = Enabled 0 = Disabled

H	ME Result may be 1 or 0 This reports how the EXJ was configured with the ME command. This parameter currently has no effect upon the operation of the meter.
I	Clock Enable 1 = Enabled 0 = Disabled
J	Clock Sync to Line 1 = Enabled 0 = Disabled
K	Count Load Rate 4 1 = Enabled 0 = Disabled
L	Enable External EODI Input 1 = Enabled 0 = Disabled
M	Calculate kVA 1 = From Q 0 = From Vars
N	kVA Reactive Channel, Values 0-3 for Channels 1-4
PPPPP	Communication Time-out in Seconds (Range 0-600 seconds)
QQQQQ	Answer Start Time (Modem), Decimal 0-1439 for minutes of the day
RRRRR	Answer Stop Time (Modem) Decimal 0-1439 for minutes of the day
S	Answer Delay Rings.
T	Bell Type Modem 1 = Bell Type 0 = CCITT (Currently only Bell supported)
U	Register Read Like Log 1 = Enabled 0 = Disabled
V	Auto Freeze at Midnight 1 = Enabled 0 = Disabled
W	Number of Mass Memory Channels Stored (Valid Values - 1-5)
X	Mass Memory Interval Length 1-60 in ASCII Representation
YYYYY	Mass Memory Channel Assignments Each Y may have value "1" - "5" which corresponds to EXJ ™ Register Channel 1-5.
Z	Daylight Savings Time Enable 1 = Enable 0 = Disable
#####	Maximum Mass Memory Queue Size (0-65535)

VV - Verify Divisors

This command returns the current divisors of the Total Register channels. Also see the DV command.

SOH	HOA	LOA	***V***	***V***	STX	ETX	BCC

The response from the VV command is:

SOH	HOA	LOA	***D***	***V***	STX	D	X	X	X
D	X	X	X	D	X	X	X	D	X
X	X	D	X	X	X	ETX	BCC		

where: The text of the response is five, 4-digit decimal numbers with leading zeroes, one number for each channel.

ZZ - Hibernate

This command stops the clock's oscillator to reduce power consumption for long term storage. The EXJ Register is inoperable after this command is issued.

SOH	HOA	LOA	***Z***	***Z***	STX	ETX	BCC

There is no response to this command.

A power-up of the EXJ Register restores operation.

4.9.1. COMMAND EXAMPLES

This section will illustrate a few command examples and the EXJ Register's response. Let us assume that we are using a cold-started meter with default settings and a dumb terminal.

Command Sent: Freeze: ^A10FF^A

Reply: ACK.

Command Sent: Log: ^A10LL^A

Reply:

```
Unit 10  JEM-1  09/11/89 15:09:11  15 Minute Demand  00
Minute Window
Channel Total            Peak  CumPeak  Minute  Time of Peak
Name    Consum  Demand  Demand  Demand  Demand     Demand
Chn 1   000000  000000  000000  000000  000000  00/00/00
00:00
Chn 2   000000  000000  000000  000000  000000  00/00/00
00:00
Chn 3   000000  000000  000000  000000  000000  00/00/00
00:00
Chn 4   000000  000000  000000  000000  000000  00/00/00
00:00
Chn 5   000000  000000  000000  000000  000000  00/00/00
00:00
T.R. 05:48
```

Command Sent: Password Activate: ^A10PA^B000000^C^Q

Reply: ACK.

Command Sent: Set Demand Interval: ^A10D1^B3005^C^K

Reply: ACK.

Command Sent: Freeze: ^A10FF^A

Reply: ACK.

Command Sent: Log: ^A10LL^A

Reply:

```
Unit 10 JEM-1   09/11/89 15:12:10   30 Minute Demand  05
Minute Window
Channel Total            Peak   CumPeak  Minute  Time of Peak
Name    Consum  Demand  Demand  Demand  Demand     Demand
Chn 1   000000  000000  000000  000000  000000  00/00/00
00:00
Chn 2   000000  000000  000000  000000  000000  00/00/00
00:00
Chn 3   000000  000000  000000  000000  000000  00/00/00
00:00
Chn 4   000000  000000  000000  000000  000000  00/00/00
00:00
Chn 5   000000  000000  000000  000000  000000  00/00/00
00:00
T.R. 02:49
```

Command Sent: Download Format Table: ^A10DF^C

Reply: CL1'Unit 'AS3'JEM-1'S3DS3I' Minute Demand 'W'Minute Window'CLZRCLE

Command Sent: Upload Format Table: ^A10UF^BCLAS3DCLV11S2'KWH '21V13' KWDP'CLE^C^@

Reply: ACK.

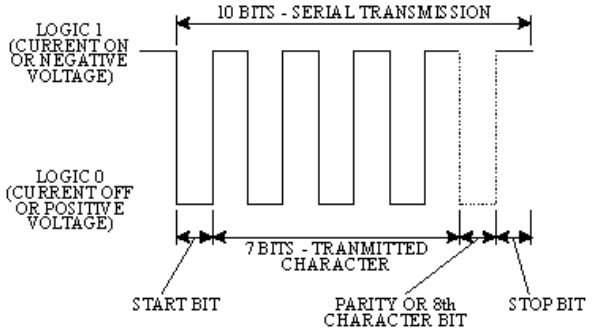
Command Sent: Download Format Table: ^A10DF^C

Reply:		`CLAS3DCLV11S2'KWH '21V13' KWDP'CLE`
Command Sent:	Freeze:	`^A10FF^A`
Reply:		`ACK.`
Command Sent:	Log:	`^A10LL^A`
Reply:		10 09/11/89 15:13:58 000000 KWH 000000 KWDP

4.10. SERIAL COMMUNICATIONS SPECIFICATIONS

ASCII Transmission Characteristics

Data are transmitted or received serially with the least-significant bit first. (ANSI X3.15-1976). The transmission is asynchronous, consisting of one start bit, eight data/parity bits, and one stop bit, for a total of ten bits per character.



ASCII Signal Characteristics

Bit parity may be even, odd, or ignored, per ANSI X3.16-1976. The data transmission rate ranges from 300 to 2,400 bits per second. Communications are half duplex: the EXJ Register will ignore incoming commands as long as data are being returned to the host.

	Columns (High Order)	b7	0	0	0	0	1	1	1	1
		b6	0	0	1	1	0	0	1	1
ROWS (Low Order)		b5	0	1	0	1	0	1	0	1
b3	b2	b1	b0		0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE		0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	syn	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10"A"	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11"B"	VT	ESC	+	;	K	[	k	{
1	1	0	0	12"C"	FF	FS	,	<	L	\	l	|
1	1	0	1	13"D"	CR	GS	-	=	M	]	m	}
1	1	1	0	14"E"	SO	RS	.	>	N	^	n	~
1	1	1	1	15"F"	SI	US	/	?	O	_	o	DEL
					Control Characters		Textual (Non-Control) Characters					

ASCII Code Table 1

Ctrl	DEC	HEX	Char
@	0	00	NUL
A	1	01	SOH
B	2	02	STX
C	3	03	ETX
D	4	04	EOT
E	5	05	ENQ
F	6	06	ACK
G	7	07	BEL
H	8	08	BS
I	9	09	HT
J	10	0A	LF
K	11	0B	VT
L	12	0C	FF
M	13	0D	CR
N	14	0E	SO
O	15	0F	SI
P	16	10	DLE
Q	17	11	DCI
R	18	12	DC2
S	19	13	DC3
T	20	14	DC4
U	21	15	NAK
V	22	16	SYN
W	23	17	ETB
X	24	18	CAN
Y	25	19	EM
Z	26	1A	SUB
[	27	1B	ESC
/	28	1C	FS
]	29	1D	GS
^	30	1E	RS
_	31	1F	US

DEC	HEX	CHAR
32	20	SPA
33	21	!
34	22	"
35	23	#
36	24	$
37	25	%
38	26	&
39	27	'
40	28	(
41	29	)
42	2A	*
43	2B	+
44	2C	,
45	2D	-
46	2E	.
47	2F	/
48	30	0
49	31	1
50	32	2
51	33	3
52	34	4
53	35	5
54	36	6
55	37	7
56	38	8
57	39	9
58	3A	:
59	3B	;
60	3C	<
61	3D	=
62	3E	>
63	3F	?

DEC	HEX	CHAR
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4A	J
75	4B	K
76	4C	L
77	4D	M
78	4E	N
79	4F	O
80	50	P
81	51	Q
82	52	R
83	53	S
84	54	T
85	55	U
86	56	V
87	57	W
88	58	X
89	59	Y
90	5A	Z
91	5B	[
92	5C	\
93	5D	]
94	5E	^
95	5F	_

DEC	HEX	CHAR
96	60	`
97	61	a
98	62	b
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k
108	6C	l
109	6D	m
110	6E	n
111	6F	o
112	70	p
113	71	q
114	72	r
115	73	s
116	74	t
117	75	u
118	76	v
119	77	w
120	78	x
121	79	y
122	7A	z
123	7B	{
124	7C	|
125	7D	}
126	7E	~
127	7F	DEL

ASCII Code Table 2

4.11. USING THE ASCII PROTOCOL BLOCK-CHECK CHARACTER

As mentioned previously, the EXJ Register uses a "block-check" or linear redundancy test to insure data integrity in the ASCII protocol. Beginning with the character following the SOH, each character is exclusive OR'd with the one following. The result is appended to the end of the command.

As an example, let us compute the block-check character for an EXJ Register READ command, using a sequence character of "A" and an address of "C2."

Character	ASCII Representation	
	Hexadecimal	Binary
SOH	(Not Included in BCC)	
HOA (“C”)	43	100 0011
LOA (“2”)	32	011 0010
“R”	52	101 0010
SEQ (“A”)	41	100 0001
BCC	62	110 0010

ASCII Block Check Character

Thus, the block-check sum is a hexadecimal 62, and the block-check character would be a lowercase "b."

4.12. GROUNDING CONSIDERATIONS

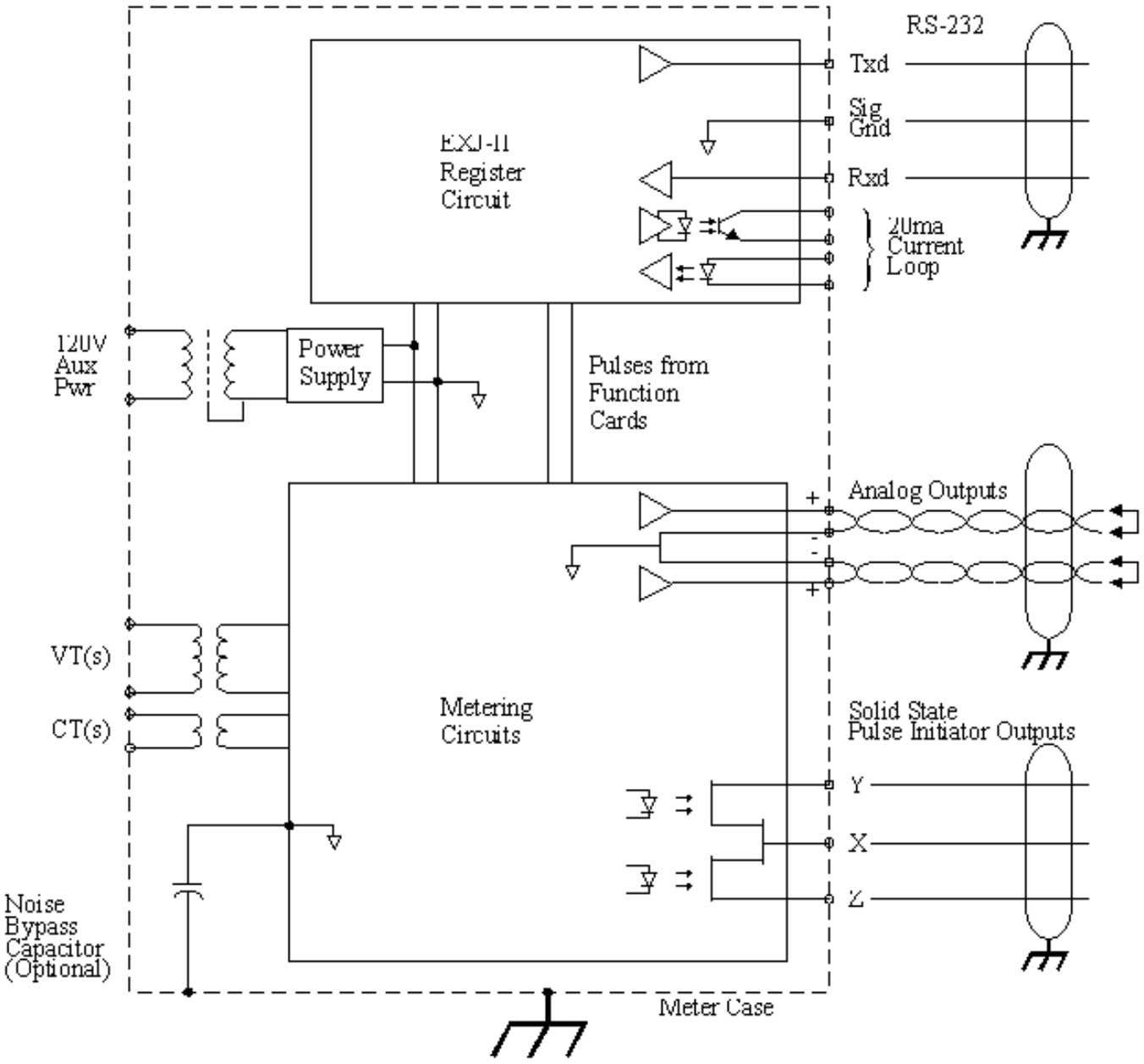
When using the EXJ Register with a JEM 1 meter, there can be **both** analog and digital signals in a single system. The unbalanced analog signals are generated in the JEM 1's function boards, and the digital interfaces arise from within the EXJ Register.

Both of these signals are referenced to the power supply's common potential of the JEM 1. Therefore, a ground-loop may be formed if the RS-232C signals **and** one or more of the analog signals are inadvertently connected together outside of the JEM 1/EXJ Register combination. This unintended connection could occur either through another piece of equipment or through a ground path.

There is no connection within the JEM 1 which ties the power supply's common potential to ground. Any and all signal grounding is, therefore, done by the user.

When connecting to the analog outputs of the JEM 1, shielded, twisted-pair cables should be used, with the outer braid connected to earth ground at the receiving devices' enclosures. The EXJ Register's RS-232C compatible port should also be connected to a shielded cable, with its outer braid connected to the receiving device's PROTECTIVE GROUND terminal, or to the receiving device's enclosure.

In some applications, the EXJ Register's current loop interface is used for serial communications in lieu of the RS-232C compatible port. Because the current-loop interface is optically isolated from the EXJ Register, there is no ground connection within the EXJ Register on this port. The same is true in the EXJ Register's external optical port.



Notes:

1. ANALOG OUTPUTS HAVE A COMMON CIRCUIT RETURN (COMMON NEGATIVE) WHICH IS ALSO CIRCUIT OR SIGNAL GROUND.

2. RS-232 SIGNAL GROUND IS CONNECTED TO THE SAME CIRCUIT COMMON.

3. 20mA CURRENT LOOP AND XYZ OUTPUTS ARE ISOLATED FROM CIRCUIT GROUND (TO 1500 V).

Block Diagram of JEM 1 Interface Connections and GroundingBINARY COMMANDS on EXJ REGISTER and JEM®2

Command	Extension	JEM® Binary	EXJ Binary	Password Required	Hardware Key Required	Function
05		† ✓	✓			Query Status
50	01	✓	✓			Password Activate
50	03	† ✓	✓	✓	✓	Password Change
50	02	✓	✓			Password Deactivate
4C	01	† ✓	✓			Freeze
52	01	† ✓	✓			Read All Registers
54	01	✓	✓	✓	✓	Time Set
54	03	✓	✓			Time Verify - Last Freeze
54	04	✓	✓			Time Verify - Last BPR as of Last Freeze
49	01	✓				Interval Control
54	02	✓	✓			Time Verify (Current)
44	02	† ✓	✓	✓		Load Profile
42	01	† ✓	✓	✓		Billing Period Reset
53	01	† ✓	✓	✓		Health Check
43	03	✓				Configuration Verify
4C	02		✓	✓		Erase Mass Memory
		† See command descriptions below for noted differences				

Binary Commands on EXJ Register and JEM®2

EXJ Register's implement enough JEM 2 commands under JEM 2 binary protocol so that JART can retrieve data from an EXJ Register. Because of differences between EXJ Registers and JEM 2 Meters, some of the JEM 2 commands that are implemented by EXJ Registers are different. This section describes these differences.

05 Query Status

The JEM 2 always reports 16K, regardless of whether there is any mass memory or not. The EXJ Register reports mass memory size, truncating down to the nearest K of memory that is less than or equal to the actual amount of mass memory.

50 03 Password Change

The JEM 2 can handle all values for the six bytes of the password. The EXJ Register can also handle all values under binary protocol; but on an EXJ Register, some passwords that are OK under binary protocol cannot be activated under ASCII protocol. This is because the ASCII protocol isn't fully transparent. The ASCII protocol cannot handle some control characters in the header or text portion of a message. The ASCII protocol also cannot handle characters whose code is greater than 127, because the ASCII protocol uses only 7-bit characters.

4C 01 Freeze

A JEM 2 copies the working and storage display registers to another area. The EXJ Register doesn't have working and storage registers. It only has "REGISTERS." These registers are copied to a FREEZE AREA in memory.

52 01 Register Read

A JEM 2 replies with either only the single frozen register requested, or all of the frozen registers. An EXJ Register always replies with 20 frozen registers.
A JEM 2 only has 20 frozen registers to read, but an EXJ Register has 30 frozen registers. If an EXJ Register replied with all 30 frozen registers, then the format of the reply wouldn't be the same as the JEM 2 and would confuse JART/JAV/etc. To maintain the same format as the JEM 2, only 20 of the 30 frozen EXJ Register are reported in the reply. The Select Registers (sr) command under ASCII protocol must be used to select which 20 of the 30 frozen EXJ Registers are reported in the reply, and in which order.

44 02 Load Profile

The EXJ Register faithfully maintains the JEM 2 format of the response, however, there are some differences. The EXJ Register can have much more load profile than the JEM 2. The JEM 2 can only hold about 16K of load profile data. The EXJ Register can hold up to about 53K of load profile data.

In load profile interval data, a JEM 2 can generate quantities that are negative. One will never see such negative quantities from an EXJ Register. All quantities from an EXJ Register are non-negative.

A JEM 2 remembers up to 40 day pointers. An EXJ Register remembers up to 63 day pointers. For either meter, if it is asked for more days of load profile than it has day pointers, then it will dump all load profiles.

The following table shows the approximate number of days that the EXJ Register can record load profile information. This table assumes maximum memory configured and shows the days for various interval sizes and channels active.

Interval Size (Minutes)	Number of Channels			
	1	**2**	**3**	**4**
60	828	442	301	228
30	442	228	154	116
20	301	154	103	78
15	228	116	78	58
12	184	93	62	47
10	154	78	52	39
6	93	47	31	23
5	78	39	26	19
4	62	31	21	15
3	47	23	15	11
2	31	15	10	7
1	15	7	5	3

Table of Load Profile Storage Days for Maximum Memory

Important Note:
When changing mass memory parameters such as queue size, channel configuration or interval length, you must erase mass memory.

Billing Period Reset Special Event

A Billing Period Reset on a JEM 2 performs a freeze, then copies or accumulates working registers into storage registers. It leaves two special events in mass memory, a Freeze Special Event and a Billing Period Reset Special Event. The two special events usually occur together, but occasionally an interval of load profile data sneaks in between the two special events.

An EXJ Register Demand Reset stores a Billing Period Reset Special Event in mass memory. A Demand Reset adds the demand peak registers to the cumulative demand peak registers, and then clears the demand peak registers and their new peak flags. There are no storage registers for a backup copy. A Demand Reset doesn't automatically do a Freeze in versions 2.10 but does do a Freeze in later versions.

In Revision 2.10, a Billing Period Reset command executed under JEM 2 Binary Protocol on an EXJ Register is the same as a native EXJ Register demand reset. In versions later than 2.10, this command will behave more like it does in a JEM 2 Meter by doing a freeze before the demand reset.

Working Register Set Special Event.

An EXJ Register generates a Working Register Set Special Event when the Preset Registers (totals only) command is executed. The Preset Registers command is the closest thing that the EXJ Register has to the JEM 2 Working Register Set.

Unscheduled Reset Special Event

From a JEM 2, this indicates that the mass memory is OK, but that other major system errors occurred. An EXJ Register doesn't have the capability of reporting such an error. Instead, it generates this special event whenever the configuration or register checksums have failed. The loss of mass memory accompanies a register checksum failure.

Register Freeze Special Event

The difference between a JEM 2 and EXJ Register freeze is the registers being frozen in an EXJ Register. A JEM 2 has ten working and ten storage registers. An EXJ Register has thirty registers.

42 01 Billing Period Reset

A Billing Period Reset on a JEM 2 performs a freeze, then copies or accumulates working registers into storage registers. It leaves two special events in mass memory, a Freeze Special Event and a Billing Period Reset Special Event. The two special events usually occur together, but occasionally an interval of load profile data sneaks in between the two special events. 53 01 Health Check

There are many small differences between a JEM 2 and an EXJ Register for this command.

EXJ Register's don't have Main Software Numbers. The EXJ Register fills the Main Software Numbers with the date of its software in unpacked BCD in YYMMDD format.

EXJ Register's don't have Option Software Numbers. This field is filled in with zeros.

EXJ Register's don't have Communications Software Numbers. This field is filled in with zeros.

EXJ Register's don't have Configuration Software Numbers. This field is filled in with zeros.

EXJ Register's don't have an Address/Scalar switch. This field is filled in with a zero.

EXJ Register's don't have a Transformer Loss Compensation switch. This field is filled in with 30 (hex).

The potential indicators are reported as being active if they are above the threshold and have not failed.

An EXJ Register doesn't distinguish present errors from past ones. An EXJ Register reports the same information for both. The EXJ Register doesn't report anything for the unscheduled billing period reset error field. A battery failure is reported if the failure of any EXJ Register batteries has been detected. There can be several batteries on an EXJ Register, as opposed to a JEM 2's single battery. Some of the EXJ Register batteries are embedded in chips with no way of testing battery status. An EXJ Register always reports A/D as working.

EXJ Register's don't have billing rates. The current billing rate field is set to 03 (hex) for on-peak.

Additional Reference Documents

JEM®2 Binary Protocol Load Profile Response *QL-12805-001-N*

5 GLOSSARY

ACK

An ASCII control character, defined as a hexadecimal 06 (06 with even parity). This communication character is a reply to a correctly received message.

ANSI

American National Standards Institute.

ASCII

American Standard Code for Information Interchange. A seven-bit binary-to-text code (eight bits when parity is included) commonly used in data transmission. ASCII is defined in ANSI Standard X3.4-1977.

BAUD

A unit of data transmission speed equal to the number of bits per second. Named for Jean-Michael E. Baudot (18??-1913), inventor of the telegraphic typewriter.

BCC

Block Check Character. An ASCII character computed by testing the contents of a body of data in linear redundancy, and appended to the end of the data before transmission; also, such a character computed and tested after receipt of such a body of data. (See ANSI X3.28-1976, paragraph 4.3.1.)

BEL

An ASCII control character, defined as a hexadecimal 07 (87 with even parity). This communication character commands the data terminal equipment to sound an audible signal.

BINARY

Pertaining to a number system with two numeric symbols: zero (0) and one (1). Used in digital computers, where the presence or absence of a voltage represents a given number.

BIT

A fundamental unit of data transmission, representing a zero (0) or a one (1). Back formation of "**B**inary dig**IT**."

CCITT

International Telegraph and Telephone Consultative Committee.

CONTROLLER

A device which acts as a "master," or originator of commands during communications with the EXJ Register, or with any other remote device. Typically a human operator, using a computer or terminal, or a computer operating independently (i.e., a SCIENTIFIC COLUMBUS JART system).

CTS

Clear To Send. A handshaking signal defined under EIA RS-232C. This signal is typically sent after connection is made by the data communications equipment.

DCE

Data Communications Equipment. A device (modem, radio-frequency or fiber-optic link, etc.) which connects the data terminal equipment with a distant point.

DSR

Data Set Ready. A handshaking signal defined under EIA RS-232C. This signal indicates to the data terminal equipment that the data communications equipment is prepared to transmit data.

DTE

Data Terminal Equipment. A device (printing or display terminal, computer, etc.) which originates and ultimately receives data.

DTR

Data Terminal Ready. A handshaking signal defined under EIA RS-232C. This signals the data communications equipment that the data terminal equipment has data to be transmitted.

DUPLEX

Relating to the transmission of serial digital and/or voice data. **Full duplex** refers to simultaneous data transmission in both directions between two points. **Half duplex** refers to separate transmissions, each direction in turn.

EIA

Electronic Industries Association.

ETX

An ASCII control character, defined as a hexadecimal 03 (03 with even parity). This communication character marks the end of a body of textual data, typically within a larger transmission of data.

HANDSHAKING

A sequence of exchanged control signals, data characters, etc., designed to establish and/or maintain data communication between systems, or between elements within a system.

HEXADECIMAL

Pertaining to a number system with sixteen numeric symbols: the decimal numerals zero (0) through nine (9), and the Roman alphabet characters "A" through "F." Used in computer programming languages to conveniently represent the values of four conterminous bits.

MARK

A voltage level or signal frequency representing a binary one.

NAK

An ASCII control character, defined as a hexadecimal 15 (95 with even parity). This communication character is sent in response to an incorrectly received data transmission, typically a failure of a block-check or parity test.

PARITY

A data testing system which counts the number of binary ones in a given character, and appends a bit onto the character whose binary value identifies that count as either an even or an odd number.

PG

Protective Ground. A reference level defined under EIA RS-232C. Typically a braid or foil shield surrounding the serial data cable, and connected to chassis or earth ground.

RS-232C

An EIA Recommended Standard, defining signal levels, transmission rates and handshaking for serial data communications. Often abbreviated as "RS-232."

RTS

Request To Send. A handshaking signal defined under EIA RS-232C. This signal is typically sent to instruct the data communication equipment to prepare for transmission (dial-up, turn on transmitter, etc.).

RXD

Received Data. A data signal, defined under EIA RS-232. Typically refers to data returned **from** the DCE **to** the DTE.

SG

Signal Ground. A reference level, defined under EIA RS-232C. The common electrical level against which all data and handshaking signals are measured.

SOH

An ASCII control character, defined as a hexadecimal 01 (81 with even parity). This communication character usually marks the beginning of a particular body of serial data, such as a command. All EXJ Register ASCII commands begin with a SOH character.

SPACE

A voltage level or signal frequency representing a binary zero.

STX

An ASCII control character, defined as a hexadecimal 02 (82 with even parity). This communication character marks the beginning of a body of textual data, typically within a larger transmission of data.

TXD

Transmitted Data. A data signal, defined under EIA RS-232C. Typically refers to the data sent **to** the DCE **from** the DTE.

V.24

A CCITT Proposed Standard defining signal levels, data transmission rates, and handshaking for serial data communications. Similar in most respects to RS-232C.