รายงานการวิจัยฉบับสมบูรณ์

โครงการ (ภาษาไทย)

การสร้างเครื่องดึงคอแบบง่าย ที่เหมาะสำหรับการประยุกต์ใช้เองที่บ้าน หรือการออกชุมชน

(ภาษาอังกฤษ)

Invention Simple Cervical Traction for Home and Community Application

คณะผู้วิจัย/ผู้วิจัย

ผศ. ดร. อรวรรณ ประศาสน์วุฒิ (หัวหน้าโครงการ)

ภาควิชา กายภาพบำบัด คณะเทคนิคการแพทย์ มหาวิทยาลัยเชียงใหม่

ผศ. ดร. ภัทรพร กมลเพ็ชร

ภาควิชาเครื่องกล คณะวิศวกรรมศาสตร์ มหาวิทยาลัยเชียงใหม่

เสนอต่อ

ศูนย์วิศวกรรมชีวการแพทย์ มหาวิทยาลัยเชียงใหม่

30 กันยายน 2551

กิตติกรรมประกาศ

คณะผู้วิจัย ขอขอบคุณ อาสาสมัครและผู้ป่วยทุกท่าน ที่มีส่วนร่วมในงานวิจัยนี้ ที่สำคัญอย่างยิ่ง สำหรับความสำเร็จลุล่วงเป็นอย่างดีของงานวิจัยนี้ คณะผู้วิจัยใคร่ขอขอบคุณ ศูนย์วิศวกรรมชีวการแพทย์ มหาวิทยาลัยเชียงใหม่ ที่ให้ความสนับสนุนทางด้านงบประมาณ ในปีงบประมาณ 2551 ในการสร้างเครื่องดึงคออย่างง่ายนี้ขึ้น ซึ่งจะเป็นประโยชน์ต่อผู้ป่วยที่มีอาการปวดคอในระดับชุมชนต่อไป

คณะผู้วิจัย

1. หัวหน้าโครงการวิจัย

ชื่อ (ภาษาไทย) ผศ.ดร. อรวรรณ ประศาสน์วุฒิ

ชื่อ (ภาษาอังกฤษ) Assistant Professor Dr. Orawan Prasartwuth

วุฒิการศึกษา ปริญญาเอกสาขาชีวการแพทย์ (Biomedical Sciences) ออสเตรเลีย

ประสบการณ์

1989 – ปัจจุบัน : อาจารย์ประจำภาควิชากายภาพบำบัด คณะเทคนิคการแพทย์ มหาวิทยาลัยเชียงใหม่

ผลงานทางวิชาการ (งานตีพิมพ์ในวารสารนานาชาติที่มี peer reviews)

1. **Prasartwuth O**, Binboga E, Turker KS (2008). A study of synaptic connection between low threshold afferent fibres in common peroneal nerve and motoneurones in human tibialis anterior, Experimental Brain Research. 2008 In press

2. Allen TJ, Butler JE, Gandevia SC, **Prasartwuth O** and Taylor JL (2006). Muscle damage and exercise: does the brain contribute to muscle weakness? Physiology News. 64, 21-22.

3. **Prasartwuth O**, Allen TJ, Butler JE, Gandevia SC, Taylor JL (2006). Length-dependent changes in voluntary activation, maximal voluntary torque and twitch responses after eccentric damage in humans, Journal of Physiology. 571: 243-252 (Impact factor 4.346)

4. **Prasartwuth O**, Taylor JL, Gandevia SC (2005). Maximal force, voluntary activation and muscle soreness after eccentric damage to human elbow flexor muscles, Journal of Physiology, 567: 337-348 (Impact factor 4.346)

รางวัลที่เคยได้รับ

1. Scholarship from the Ministry of University Affairs of Thailand, 2002 -2005
2. Scholarship from Chiangmai University, 2001 - 2002
3. Scholarship from the Australian Agency for International Development (AusAid), 1994 – 1997.

4. Best Oral Presentation Awards at International Scientific Congress: 1st Asian Indoor Games; October 17-19, 2005; Bangkok, Thailand
5. Best Oral Presentation Awards by student in early stages of degree at Research Student Conference 2003, School of Biomedical Sciences, The University of Sydney. June 11, 2003; Australia

ทุนวิจัยที่ได้รับ

2008-2009	Sport Authority of Thailand (PI)
2006-2008	Thailand Research Fund and Ministry of University Affairs Grant (PI)
2007-2008	Biomedical Engineering Program Grant, Faculty of Engineering, Chiangmai University (PI)
2006-2007	Biomedical Engineering Program Grant, Faculty of Engineering, Chiangmai University (PI)
1998-1999	Supporting New Researcher Fund, Chiangmai University (PI)

ตำแหน่ง	ผู้ช่วยศาสตราจารย์
สถานที่ทำงาน	ภาควิชากายภาพบำบัด คณะเทคนิคการแพทย์ มหาวิทยาลัยเชียงใหม่
หมายเลขโทรศัพท์	66 53 94 9246
โทรสาร	66 53 946042
e-mail address	oprasa@chiangmai.ac.th

2. ผู้ร่วมวิจัย

ชื่อ (ภาษาไทย) ผศ.ดร. ภัทราพร กมลเพ็ชร

ชื่อ (ภาษาอังกฤษ) Assistant Professor Dr. Patrapon Kamonpet

วุฒิการศึกษา ปริญญาเอกสาขาวิศวกรรม (Plastic Engineering) สหรัฐอเมริกา

ประสบการณ์

1990 – ปัจจุบัน : อาจารย์ประจำภาควิชาเครื่องกล คณะวิศวกรรมศาสตร์ มหาวิทยาลัยเชียงใหม่

ผลงานทางวิชาการ

1. Srihajong, N., Ruamrungsri, S., Terdtoon, P., **Kamonpet, P.**, and Ohyama, T., " Heat pipe as a cooling mechanism in an aeroponic system," *Applied Thermal Engineering* , vol.26, n.2-3, February 2006, pp.267-276.

2. S. Rittidech, P. Terdtoon, M. Murakami, **P. Kamonpet**, and W. Jompakdee, " Correlation to predict heat transfer characteristics of a closed-end oscillating heat pipe at normal operating condition," *Applied Thermal Engineering*, vol.2003, n.23, 2003, pp.497-510.

3. N. Waowaew, P. Terdtoon, S. Maezawa, **P. Kamonpet**, and W. Klongpanich, " Correlation to Predict Heat Transfer Characteristics of A Radially Rotating Heat Pipe at Vertical Position," *Applied Thermal Engineering*, vol.2003, n.23, 2003, pp.1019-1032.

รางวัลที่เคยได้รับ -

ตำแหน่ง ผู้ช่วยศาสตราจารย์

สถานที่ทำงาน ภาควิชาเครื่องกล คณะวิศวกรรมศาสตร์ มหาวิทยาลัยเชียงใหม่

หมายเลขโทรศัพท์ 66 53 94 4146 ต่อ 949

โทรสาร 66 53 944185

e-mail address patrapon@yahoo.com

บทคัดย่อ

งานวิจัยนี้มีจุดประสงค์เพื่อสร้างเครื่องดึงคอที่อาศัยหลักการพื้นฐานทางวิศวกรรม โดยมีราคาประหยัด หาวัสดุได้โดยง่าย รวมถึงน้ำหนักเบา มีขนาดกระทัดรัด สามารถนำออกไปใช้ในชุมชนได้ การออกแบบเครื่องดึงคอ ประกอบไปด้วยส่วนสำคัญ 3 ส่วน คือ ระบบดึงเชือก ระบบวัดแรง และระบบควบคุม โดยแรงดึงเชือกอาศัยการทำงานของมอเตอร์ แรงดึงในเชือกจะถูกวัดโดยตัววัดแรงและแปลงค่าเป็นตัวเลขและปรากฏที่จอแสดงผล นอกจากนี้แรงดึงเชือกถูกควบคุมโดยระบบควบคุมทิศทางการดึงและปล่อย ระบบควบคุมความเร็ว และระบบควบคุมโดยผู้ป่วย เครื่องดึงคอที่สร้างขึ้นใหม่นี้ สามารถดึงด้วยน้ำหนัก 0-25 กิโลกรัม สามารถปรับความเร็วในการดึงได้ 2 ช่วง และสามารถหยุดที่จุดกำหนดได้ มีขนาดเล็ก 14.5 x 25.5 X 30 เซนติเมตร มีน้ำหนัก 5 กิโลกรัม

หลังจากการสร้างเครื่องดึงคอนี้ ได้ทำการทดสอบผลการทำงานทั้งทางด้านวิศวกรรม และประสิทธิภาพในการรักษาผู้ป่วยทางคลินิก โดยผลการทดสอบทางวิศวกรรมมีความผิดพลาดเพียงเล็กน้อย ซึ่งอยู่ในระดับที่ยอมรับได้ สามารถปรับเลือกรูปแบบการใช้งาน เช่น ปรับแรงดึง ปรับความเร็ว ปรับให้มีการดึงค้างไว้ หรือปรับให้มีการดึงและปล่อยสลับกันไป นอกจากนี้ยังมีระบบความปลอดภัย ซึ่งสามารถหยุดการดึงได้เองโดยผู้ป่วย ส่วนผลการทดสอบประสิทธิภาพในการรักษาผู้ป่วยทางคลินิก โดยทำการศึกษาในผู้ป่วยที่มีอาการปวดคอเฉพาะที่ส่วนของคอ และผู้ป่วยที่มีอาการปวดคอทั้งแบบที่มีอาการปวดร้าว และ/หรือ ชาลงแขน โดยจะประเมินความรู้สึกเจ็บปวดด้วยสเกลวัดความเจ็บปวด (Visual analog scale) ทั้งในขณะพักและขณะที่มีการเคลื่อนไหว นอกจากนี้ยังประเมินช่วงการเคลื่อนไหว ด้วยอินไคลโนมิเตอร์และเปรียบเทียบผลการรักษาก่อนและหลังการดึงคอ ผลการศึกษาพบว่าภายหลังการดึงคอด้วยเครื่องที่สร้างใหม่ขึ้นนี้ มีผลในการช่วยในการลดปวดและเพิ่มมุมการเคลื่อนไหวของคอได้อย่างมีประสิทธิภาพ

ผลลัพธ์จากงานวิจัยนี้ มีประโยชน์อย่างมากต่อผู้ป่วยที่อยู่ในชุมชนห่างไกล และอาจรวมถึงโรงพยาบาลที่มีงบประมาณไม่มากในการซื้อเครื่องดึงคอจากต่างประเทศ เครื่องดึงคอที่สร้างขึ้นมาใหม่นี้ ถูกออกแบบตามหลักการทางวิศวกรรมและใช้อุปกรณ์ที่มีอยู่ในประเทศไทย ดังนั้นจึงมีราคาไม่แพง นอกจากนี้ยังผ่านการตรวจสอบทางวิศวกรรมและผ่านการตรวจสอบในการประยุกต์ใช้ทางคลินิกแล้ว คณะผู้วิจัยเชื่อมั่นว่าผลลัพธ์จากการนี้จะเป็นประโยชน์ในวงกว้างต่อไป

ABSTRACT

The aim of this research was to invent the simple cervical home traction with safety for patients with neck pain. This traction was designed to have a low cost and its parts can be easily found in our local shops. It also has a small size and light weight which can be carried over to apply in suburb areas. This traction consisted of three important systems: rope pull system, force measuring system and control system. The tension in the rope derived from the motor and was measured by stain gauge load cell with displayed the force value by indicator panel. It also has a direction control system, speed control system and emergency system by patients. Its maximal load was set up to 25 kilogram and speed can be adjusted at 2 periods of time. It was a light weight ~ 5 kilogram and its size were at 14.5 x 25.5 X 30 centimeters.

After inventing this cervical home traction, we tested either the engineering performance or the effective treatment in clinic. With the results in engineering performance, the errors showed slightly and in the acceptable level. As it can adjustable in several variables e.g. force, speed, static or intermittent traction and patient safety system, we are confident that this new home traction can be suitably applied in clinic with patients. We also tested our device in clinical application with neck pain patients. All patients included localized pain at their necks and referred pain and numbness to the shoulder or arm. To assess the pain level, all patients evaluated their pains by rating the visual analog scale (VAS) either during rest or during the movements. In addition, all patients were evaluated their active and passive range of movements by inclinometer. To test the efficiency of the machine in clinic, changes in signs and symptoms were compared between pre- and post-treatment in all patients. The results demonstrated that our cervical traction could efficiently relief signs and symptoms in patients with neck pain.

In conclusion, the outcomes from this research have great benefits in patients with neck pain living in suburb area. Also the hospitals that have low government fund could also get a chance to invent simple cervical traction. It is very costly because all parts can be found locally in Thailand. Importantly, it was designed based on the engineering knowledge and was passed the engineering standard test and clinical test. Therefore, we are confident that our invented cervical traction could benefits in an expansion.

สารบัญเรื่อง

สารบัญตาราง

สารบัญภาพ

คำอธิบายสัญลักษณ์และคำย่อที่ใช้ในการวิจัย

สัญลักษณ์และคำย่อ	คำอธิบาย
N	Newton
kgf	Kilogram.Force
DC	Direct current
AC	Alternate current
IC	Integral curcuit
A/D	Analog to digital
mm	Milimetre
W	Watt
rpm	Round per minute
V	Volt
NC	Normally close
kOhm	KiloOhm
SP	Set point
kg	Kilogram
NO	Normally open
กก	กิโลกรัม
ซม^3	ลูกบาศก์เซ็นติเมตร

บทนำ

ด้วยปัญหาเรื่องการปวดคอ อันมีสาเหตุจากการเสื่อมของกระดูกคอ เป็นปัญหาที่พบได้บ่อยมากในงานทางกายภาพบำบัด ผู้ป่วยจะมาด้วยอาการปวดที่บริเวณคอ บางรายอาการปวดสามารถร้าวลงไปที่บ่าและแขนได้ หากมีการกดทับเส้นประสาทร่วมด้วย ผู้ป่วยจะมีอาการชาและอ่อนแรงของกล้ามเนื้อแขนที่เส้นประสาทนั้นไปเลี้ยง อาการเหล่านี้เป็นปัญหาที่สำคัญและเป็นอุปสรรคอย่างมากในการประกอบอาชีพและการใช้ชีวิตประจำวัน แนวทางหรือวิธีการหนึ่งของการรักษาทางกายภาพบำบัดคือ การลดหรือทำให้อาการปวดหายไป โดยใช้เครื่องดึงคอ (Mechanical Cervical Traction) ที่มีหลักการทำงานโดยการสร้างแรงดึงแยกห่าง (Traction force) กระทำที่กระดูกคอโดยผ่านระบบทางกลศาสตร์ แรงที่กระทำนี้สามารถปรับได้ทั้งในรูปแบบการดึงแยกค้างไว้ตลอดเวลา และการดึงแยกแบบมีการพักเป็นช่วงๆ ผลของการรักษาโดยใช้เครื่องดึงคอคือ การเพิ่มระยะห่างหรือช่องว่างของกระดูกคอ รวมถึงลดแรงกดทับที่กระทำต่อเส้นประสาท นอกจากนี้ยังช่วยให้กล้ามเนื้อที่บริเวณคอคลายตัว กระตุ้นให้เกิดการเคลื่อนไหวของกระดูกคอ เพิ่มการไหลเวียนของเลือดที่บริเวณคอด้วย[1] ความสามารถในการลดอาการปวดคอจากการใช้เครื่องดึงคอนี้ อธิบายตามหลักการของผลทางสรีรวิทยาได้คือ การดึงคอเป็นการกระตุ้นผ่าน Mechanoreceptors มีผลต่อวงจรการปิดเปิดประตูในการควบคุมความเจ็บปวด ที่เรียกว่า Gate control theory[2] และมีผลต่อการยับยั้งการเกร็งตัวของกล้ามเนื้อผ่าน Reflex muscle guarding[3]

ถึงแม้ว่า ผลในการรักษาด้วยวิธีการดึงคอ จะมีประสิทธิภาพดี โดยเป็นที่พอใจทั้งต่อผู้ป่วยเองและผู้ให้การรักษาเป็นอย่างมาก อย่างไรก็ตามการรักษาด้วยวิธีดึงคอนี้ จะต้องกระทำอย่างต่อเนื่อง (ทุกวัน) เป็นเวลานาน (โดยเฉลี่ย ~1-2 เดือน) รวมถึงความบ่อยครั้งในการเข้ารับการรักษาด้วยเครื่องนี้ ผู้ป่วยแต่ละรายสามารถเข้ารับการรักษา โดยเฉลี่ย 1 ครั้งต่อวันเท่านั้น ด้วยเหตุนี้ผู้ป่วยจำเป็นต้องเดินทางเพื่อมาเข้ารับการรักษาทางกายภาพบำบัดที่โรงพยาบาลเป็นประจำทุกวันและเป็นเวลานานต่อเนื่องกัน ทำให้เสียค่าใช้จ่ายสูงทั้งค่ารักษา ค่าเดินทาง และอื่นๆ รวมถึงเสียเวลาในแต่ละวันค่อนข้างมาก ดังนั้นผู้ป่วยที่ประสบกับความทุกข์ทรมานกับอาการปวดที่คอกลุ่มนี้ ได้สอบถามถึงความเป็นไปได้ที่จะมีการสร้างเครื่องดึงคอแบบง่าย ที่มีความปลอดภัยสูงและสามารถประยุกต์ใช้ได้เองที่บ้าน นอกจากนี้ยังสามารถใช้ได้บ่อยครั้งตามอาการปวดที่เกิดขึ้น โดยไม่ต้องเดินทางมารับการรักษาที่โรงพยาบาล จึงเป็นที่มาของการคิดสร้างเครื่องดึงคอแบบง่ายสำหรับผู้ป่วยนำไปประยุกต์ใช้งานที่บ้านได้

นอกจากนี้แล้ว ในการให้บริการทางกายภาพบำบัดในระดับชุมชน อุปสรรคที่สำคัญคือขาดเครื่องมือที่จะสามารถพกพาออกไปได้ เนื่องจากเครื่องดึงคอที่มีอยู่ในแผนกมีขนาดใหญ่และมีน้ำหนักมาก ไม่สะดวกต่อการขนย้าย หากได้มีการสร้างเครื่องดึงคอแบบง่าย ราคาถูก ใช้วัสดุ

ภายในประเทศ สามารถใช้ช่างฝีมือระดับชาวบ้านประกอบได้ จะเป็นการเพิ่มโอกาสในการดูแลปัญหาสุขภาพของประชาชนคนไทยในระดับชุมชนได้อย่างทั่วถึง

วัตถุประสงค์

เพื่อสร้างเครื่องเครื่องดึงคอแบบง่าย ที่อาศัยการทำงานตามหลักการพื้นฐานทางวิศวกรรม มีความปลอดภัยสูง ราคาถูก ใช้อุปกรณ์ที่มีอยู่ภายในประเทศ สะดวกต่อการนำไปประยุกต์ใช้เองของผู้ป่วยที่บ้าน หรือการนำไปให้การบริการทางกายภาพบำบัดในระดับชุมชนต่อไป

ขอบเขตของการวิจัย

เป็นการออกแบบและสร้างเครื่องดึงคอ โดยวิศวกรให้ถูกต้องตามหลักการทางวิชาการ ซึ่งต้องคำนึงถึงเรื่องความปลอดภัยต่อผู้ป่วยเป็นหลักสำคัญ โดยอาศัยความร่วมมือทางวิชาการของทีมนักวิจัย นอกจากนี้ ภายหลังการสร้างเครื่องมือนี้ ทีมวิจัย จะทดสอบการทำงานของเครื่องมือนี้ว่าจะมีประสิทธิภาพเทียบเท่าหรือใกล้เคียงกับเครื่องดึงคอที่สั่งซื้อมาจากต่างประเทศ โดยการถ่ายภาพทางรังสีเปรียบเทียบการเปลี่ยนแปลงของกระดูกคอขณะดึงคอในอาสาสมัครที่ปกติ และกลุ่มผู้ป่วยที่มีอาการปวดคอ รวมถึงการประเมินผลหรือประสิทธิภาพในการรักษา และความพึงพอใจในการใช้เครื่องดึงคอแบบง่ายนี้

ความต้องการพื้นฐานของเครื่องดึงคอแบบง่าย

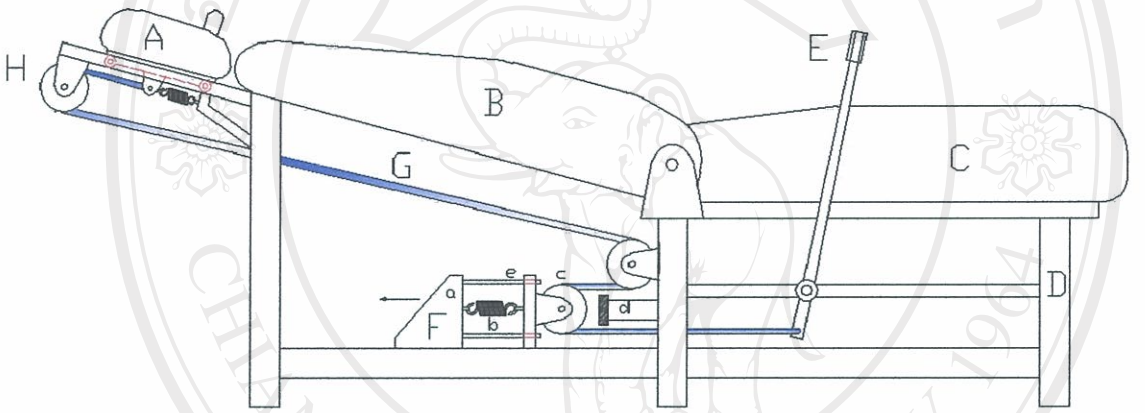
1. ราคาถูก
2. ใช้วัสดุที่หาได้ทั่วไปในท้องตลาด
3. ใช้หลักการง่ายๆ ที่ช่างตามอำเภอหรือชนบทสามารถทำเองได้
4. มีความปลอดภัยสูง
5. ขนย้ายง่าย น้ำหนักเบาถอดเก็บได้
6. ผู้ป่วยสามารถประกอบ และใช้งานด้วยตัวเองพียงคนเดียวได้

แนวความคิดที่ 1

ในการออกแบบ ในแนวความคิดที่ 1 จะเลือกระบบที่ใช้แรงจากผู้ป่วยเองในการดึง เพราะว่าทำได้ง่าย และเมื่อผู้ป่วยรู้สึกเจ็บก็จะหยุดดึงไปเอง ทำให้ความปลอดภัยสูง และเนื่องจากระบบใช้กลไกล้วนโดยไม่มีการใช้พลังงานจากแหล่งอื่นเช่นไฟฟ้าหรือลม ทำให้ใช้ได้ทุกที่แม้ถิ่นทุรกันดาร

ชิ้นส่วนสำคัญประกอบด้วย

A. Slide headrest with head lock bar
B. Seat back
C. Seat cushion
D. Equipment Frame
E. Pull rod
F. Safety mechanism and force adjustment
G. Chain
H. Pull Mechanism

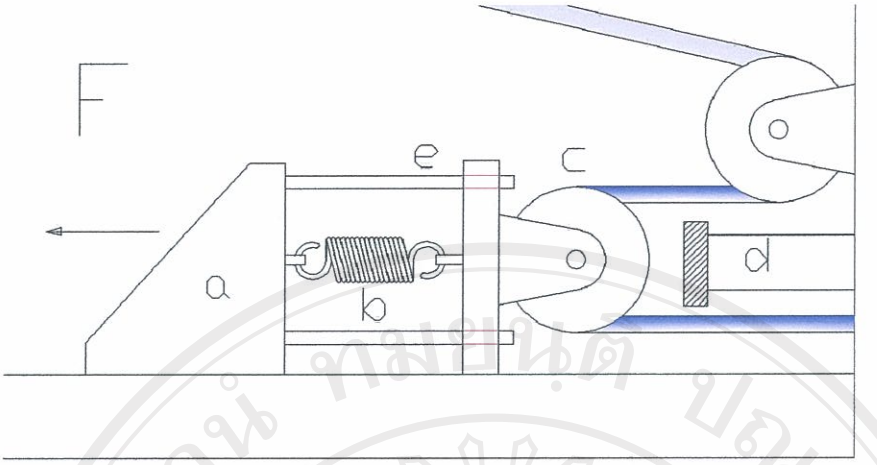


รูปที่ 1 แสดงแนวคิดแบบที่ 1 พร้อมเตียง

หลักการทำงาน

เมื่อผู้ป่วยนอนลงในตำแหน่งแนวราบ โดยวางศีรษะไว้บน Slide headrest A และปรับให้ส่วน head lock bar พอดีกับหัว หลังจากนั้นผู้ป่วย จะทำการดึง pull rod E เข้าหาตัว ซึ่งจะทำให้ Chain G ถูกดึงผ่านเฟืองชุดต่างๆ จนถึง pull mechanism H และเลื่อน slide headrest A ขึ้นด้านบน จนกระทั่งถึงจุดที่ต้องการจึงหยุดดึง โดย pull rod จะทำการทดแรง ในอัตราส่วนประมาณ 5-10 ต่อ 1 นั่นคือแรงดึงที่กระทำที่ rod 1 N จะเกิดแรงดึงประมาณ 5-10 N เพื่อให้ผู้ป่วยไม่ใช้แรงมากเกินไปจนกล้ามเนื้อเกร็งและไม่ผ่อนคลาย

เพื่อป้องกันแรงดึงจนเกิดอันตราย กลไกความปลอดภัยและการปรับเปลี่ยนแรง จะทำงานเพื่อหยุดการเคลื่อนที่โดยมีการทำงานดังนี้



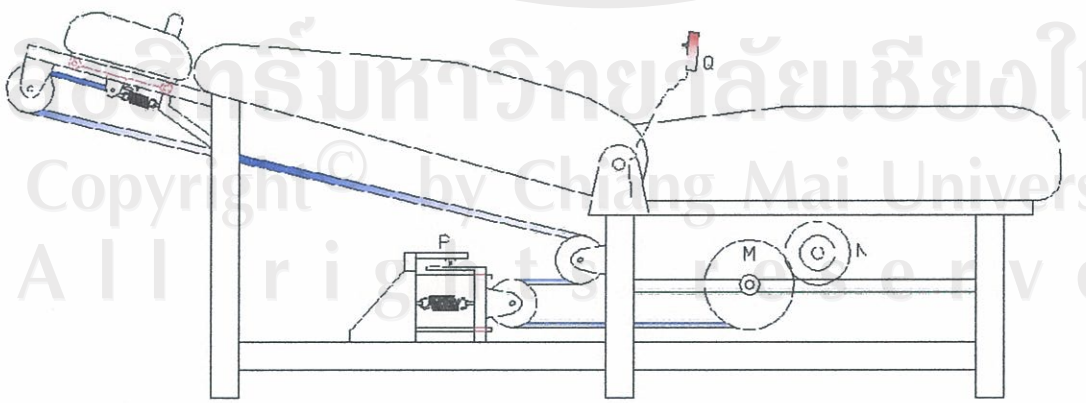
รูปที่ 2 แสดงกลไกการทำงาน

ฐานยึด a ถูกปรับไปทางซ้ายมือเมื่อต้องการเพิ่มจุดสูงสุดของแรงดึง และ ขวามือเมื่อต้องการลดแรง เมื่อ chain ถูกดึงก็จะทำให้ เฟือง c หมุนและเคลื่อนไปทางขวาตาม slide e แต่จะถูกดึงรั้งไว้ด้วยสปริง b โดยแรงที่ดึงเท่ากับซึ่งสามารถปรับแรงดึงสูงสุดได้โดยง่ายโดยการปรับแต่ง (calibrate) ด้วยตุ้มน้ำหนัก

เมื่อสปริงถูกยืดออกไปทางขวาเพราะแรงดึงที่มากขึ้นจนถึงจุดที่ตั้งไว้ก็จะชนกับตัวเบรก d ที่จะทำการล็อคเฟืองไม่ให้หมุนต่อไป

แนวความคิดที่ 2

อย่างไรก็ตามหากแนวความคิดแบบที่ 1 ไม่ได้ผลดีเนื่องจากการไม่ผ่อนคลายของคนไข้ pull rod อาจเปลี่ยนมาเป็นมอเตอร์แทน ตามรูปที่ 3



รูปที่ 3 แสดงแนวความคิดแบบที่ 2 พร้อมเตียง

โดยการเปลี่ยน จากเฟืองให้เป็นรอกและ Chain ให้เป็น cable โดยผู้ป่วยจะทำการกดปุ่มที่อุปกรณ์ควบคุม Q เพื่อขึ้นลง Slide Headrest ซึ่งจะหยุดเมื่อโดย limit switch P ที่เพิ่มขึ้นมา โดยแรงหมุนจะทำโดยชุดมอเตอร์ N และทดผ่าน ชุดเฟือง M เพื่อให้ได้แรงพอเพียง เมื่อผู้ป่วยหยุดกดปุ่มเบรก ไฟฟ้าติดชุดเดียวกับมอเตอร์ N จะทำการล็อคเพื่อคงการดึงเอาไว้ หากคนไข้ปล่อยมือหรือกดปุ่มฉุกเฉิน เครื่องปล่อยเบรกและถอยกลับ

การออกแบบใหม่

ในการสร้างชิ้นงานจริง ได้เปลี่ยนแนวความคิด ในการออกแบบแตกต่างจากในที่ได้นำเสนอในโครงร่างงานวิจัย ซึ่งเป็นกลไก แบบสปริง แบบลม แต่ในชิ้นงานจริงได้เปลี่ยนมาใช้เป็นแบบมอเตอร์และเฟืองแทน สาเหตุหลักที่ไม่สร้างตามแบบโครงสร้างที่เสนอไปในช่วงแรกเพราะ

1. ราคาวัสดุโดยรวมจะแพงเพราะสิ้นเปลืองไปกับโครงสร้างเตียงและกลไก
2. รูปแบบไม่สามารถปรับเปลี่ยน และประยุกต์การทำงานได้ ผู้ป่วยต้องอยู่ในท่าที่กำหนดเท่านั้น
3. กลไกที่เป็นลักษณะเชิงกลล้วน ยากต่อการควบคุมและปรับตั้ง
4. มีความแม่นยำและเชื่อถือต่ำ
5. ไม่สามารถต่อยอดพัฒนาระบบได้โดยง่าย

ดังนั้นการออกแบบจึงเปลี่ยน แนวความคิด ให้มีจุดดีมากขึ้น เพื่อแก้ปัญหาข้างต้นดังนี้

1. ทำการลดรูปให้ทั้งชุดกลไกที่ซับซ้อนให้มาอยู่ใกล้กันในกล่องเดียว
2. ขนาดเป็นกล่องไม่เกิน 40 x 40 x 40 ซม^3 และ น้ำหนักเบาไม่เกิน 10 กก. ทำให้ขนย้ายง่าย ใช้งาน เก็บสะดวกขึ้น ไม่มีอุปกรณ์ยุ่งยากให้ประกอบทุกอย่างจะสำเร็จรูปในกล่อง
3. ราคาถูกลงเพราะมีชิ้นส่วนกลไกน้อย หาง่ายตามท้องตลาด
4. เป็นเครื่องดึงคอที่สามารถเคลื่อนย้ายสะดวก โดยสามารถต่อกับเก้าอี้ เตียง และใช้เมื่อนอนราบกับพื้นก็ได้
5. ใช้ระบบไฟฟ้าและมอเตอร์แทน การควบคุมผ่านวงจร ควบคุมและรีเลย์ แทนกลไกเชิงกล ทำให้สามารถปรับการทำงานได้ทั้งความเร็วและทิศทาง
6. ใช้ตัววัดแรง ในการวัดแรงดึงทำให้ แม่นยำสูง มีความไวต่อการตัดต่อ
7. สามารถต่อยอดได้ เช่นการควบคุมด้วยระบบคอมพิวเตอร์หรือไมโครคอนโทเลอร์
8. ใช้เชือกพิเศษ ที่สามารถทนต่อแรงดึงได้ไม่ต่ำกว่า 150 kgf แต่มีความยืดหยุ่น ทำให้ลดการกระชากซึ่งอาจเกิดขึ้นหากใช้กลไกดึงโดยตรง การใช้เชือกทำให้ง่ายต่อการจัดท่าผู้ป่วย

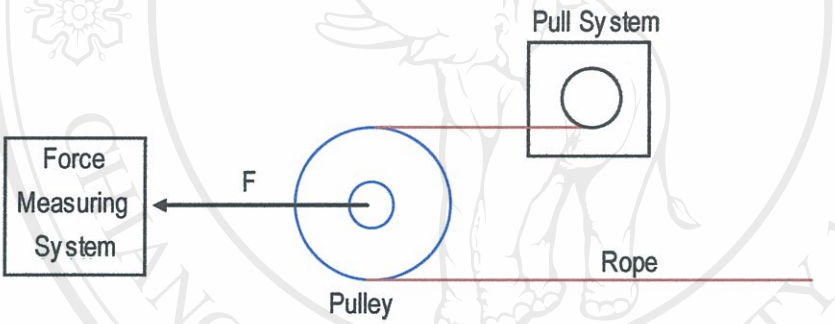
เพราะแรงดึงจะคงที่ในเส้นเชือกตลอดเส้น ไม่ว่าจะทำมุมใดหรือเอียงไปในแนวใด จะไม่มีผลต่อแรงที่วัด นอกจากนั้นระยะที่เพิ่มขึ้นทำให้เจ้าหน้าที่ทำงานได้สะดวกขึ้น

9. จอแสดงผล (Indicator Panel) เป็นแบบโครคอนโทเลอร์ ทำให้ผลของกลไก มุมของแรง ค่าปัจจัยต่างๆ ถูกกำจัดและชดเชยไปทั้งหมด ตอนปรับตั้ง (Calibrate) ทำให้การวัดแรงดึงจะได้ค่าที่ถูกต้องเสมอ

โครงสร้างพื้นฐาน

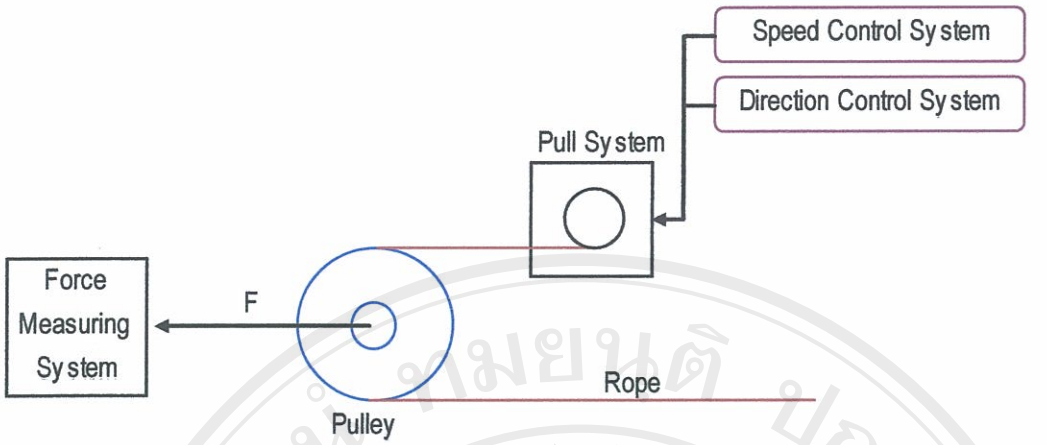
พื้นฐานการทำงานของเครื่องดึงคอเบื้องต้น จะประกอบด้วยหลักการง่ายๆ โดยมีองค์ประกอบอยู่ 3 ส่วน คือ (ดังรูปที่ 4,5 และ 6)

1. ระบบดึงเชือก (Pull system)
2. ระบบวัดแรง (Force measuring system)
3. ระบบควบคุม (Control system)



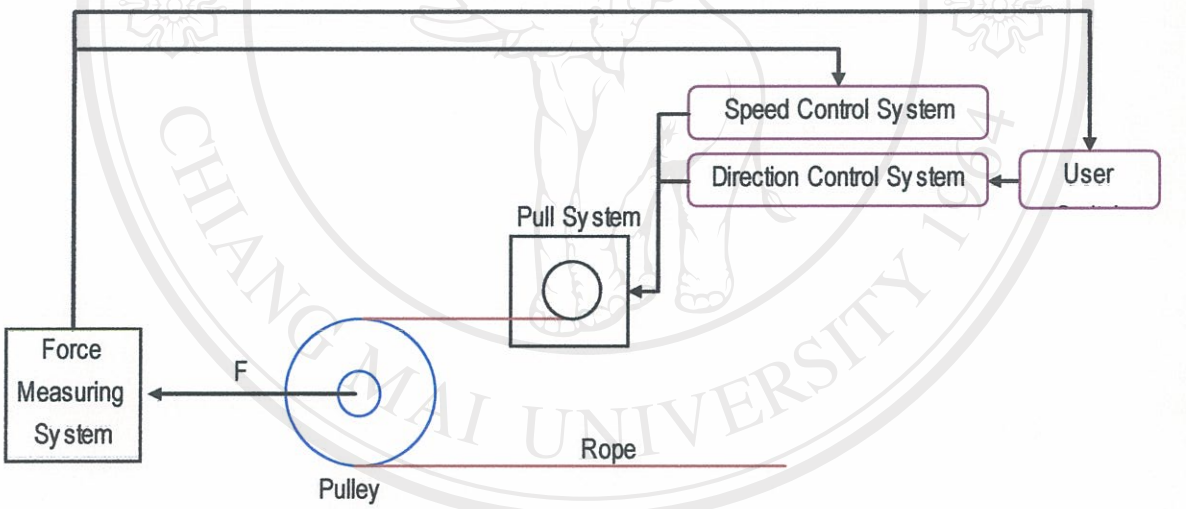
รูปที่ 4 แสดงระบบพื้นฐานและองค์ประกอบของเครื่องดึงคอ

โดยในระบบดึงเชือกนั้นจะใช้มอเตอร์ กระแสตรง12 V ในการดึงเชือก ผ่านรอกก่อนจะส่งแรงไปหาผู้ป่วย แรงที่กระทำจะวัดแรงปฏิกิริยาที่เกิดขึ้น โดยมีค่าเป็น 2 เท่าของแรงดึงในเชือก (แต่ระบบแสดงค่าจะปรับค่าให้อ่านค่าเพียงครึ่งหนึ่งเท่านั้น) เพื่อให้การดึงสามารถควบคุมได้จึงจำเป็นต้องมีระบบควบคุมทิศทางการดึงและปล่อย (Direction control system) และมีระบบควบคุมความเร็ว (Speed control system) ของการดึงเพิ่มเติม เพื่อให้สามารถปรับการดึงได้อย่างเหมาะสมและไม่อันตราย



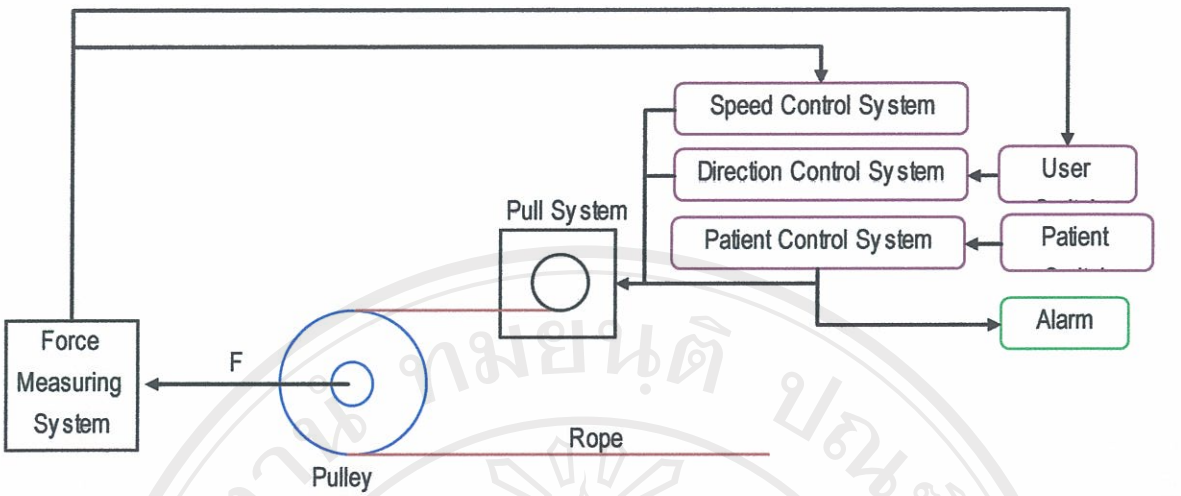
รูปที่ 5 แสดงระบบพื้นฐาน และระบบควบคุม

ในการควมคุมทิศทาง และความเร็ว ดังกล่าวจะมีการเชื่อมต่อข้อมูลจากแรงที่วัดได้ เพื่อให้การ ควมคุมสามารถทำได้อย่างอัตโนมัติมากขึ้น ดังรูปที่ 6



รูปที่ 6 แสดงทิศทางการส่งข้อมูลจากตัววัดแรงไปยังผู้ควบคุม

เพื่อป้องกันการเกิดการบาดเจ็บขณะดึง ได้มีการออกแบบให้มีการควบคุมจากผู้ป่วย กรณีเกิดความรู้สึกเจ็บจากการดึงเพิ่มขึ้น โดยให้มีระบบแจ้งกลับจากผู้ป่วยพร้อมระบบที่จะควมคุมระบบการดึงให้คลายออก รวมทั้งส่งเสียงเตือนดังขึ้น



รูปที่ 7 แสดงระบบแจ้งกลับจากผู้ป่วย

วิธีดำเนินการวิจัย

แผนการดำเนินงานตลอดโครงการ (แบบที่เสนอในข้อเสนอโครงการวิจัย)

	เดือนที่									
แผนการดำเนินงาน	1	2	3	4	5	6	7	8	9	10
ออกแบบและสร้างเครื่องดึงคอแบบง่าย										
ตรวจสอบความทำงาน										
สรุปผลและรายงานผล										

แผนการดำเนินงานจริง

	เดือนที่									
แผนการดำเนินงาน	1	2	3	4	5	6	7	8	9	10
การออกแบบและการหาเครื่องดึงคอแบบง่าย										
การสร้างเครื่องดึงคอแบบง่าย										
การตรวจสอบความทำงานเครื่องทางวิศวกรรม										
การตรวจสอบความทำงานโดยการนำไปใช้ในทางคลินิก										
สรุปผลและรายงานผล										

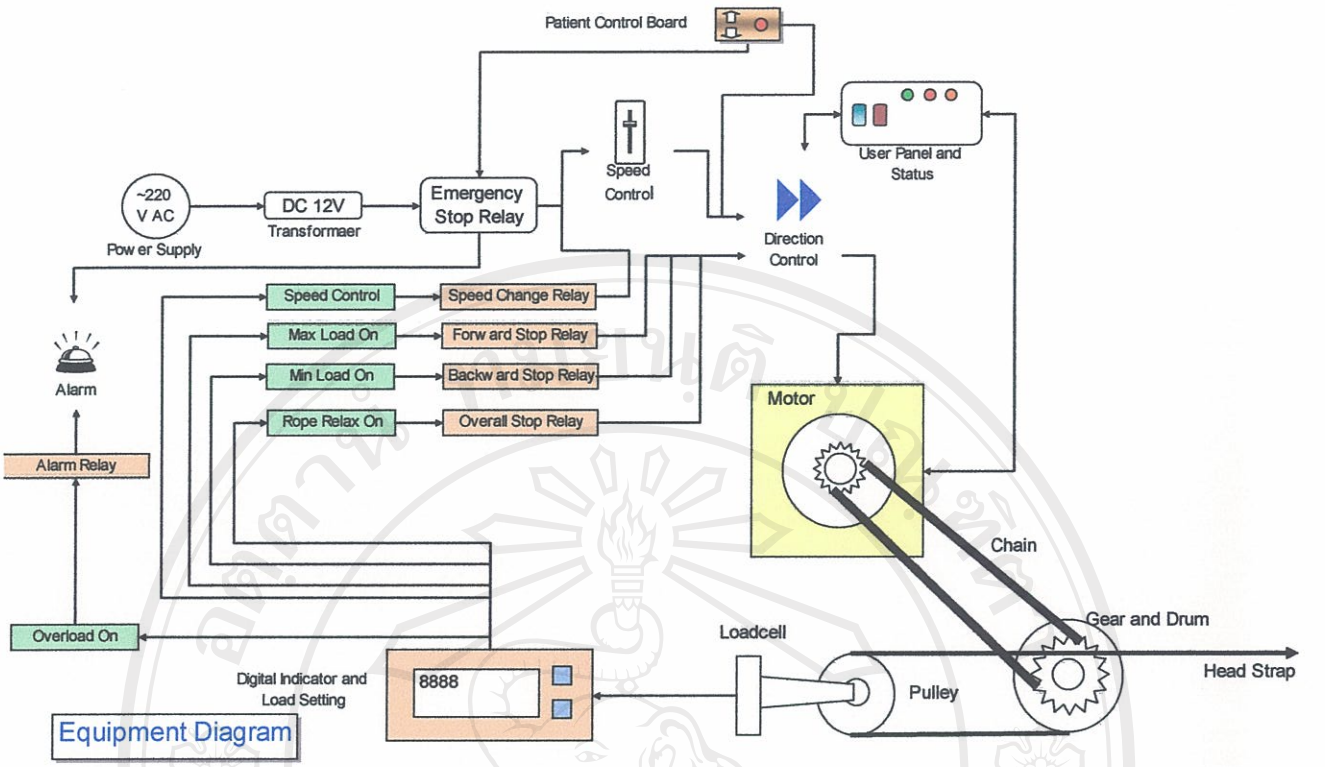
ผลงานวิจัย

ผลของการออกแบบ

ระบบที่สร้างขึ้นมาโดยรวมจะแสดงดังรูปที่ 8 ซึ่งประกอบด้วยชุดกลไกในการดึงโดยได้กำลังมาจากมอเตอร์ ซึ่งจะไปหมุนกว้านเชือกให้ดึงหรือคายออก เชือกจะถูกร้อยผ่านรอกที่ติดกับตัววัดแรงซึ่งจะเกิดแรงในตัววัดแรงเป็น 2 เท่าของแรงในเส้นเชือก สัญญาณจากตัววัดแรงจะถูกส่งไปให้อุปกรณ์แปลงสัญญาณให้เป็นตัวเลข ที่อ่านค่าได้ และยังทำการหารลงครึ่งหนึ่งทำให้ค่าที่อ่านได้ตรงกับค่าจริงในเส้นเชือกระดับของแรงดึง ซึ่งจะถูกใช้เพื่อการควบคุม ความเร็วในการดึงและทิศทางการดึงตาม สถานะการณ์ต่างๆที่เกิดขึ้น ในการทำงานเช่น เมื่อถึงแรงดึงสูงสุดที่ตั้งไว้เครื่องจะไม่อนุญาต ให้ดึงเพิ่มขึ้นอีกแต่ปล่อยคายออกได้ หรือ เมื่อแรงดึงมากขึ้นก็จะลดความเร็วในการดึงให้ช้าๆเพื่อป้องกันอันตรายและง่ายต่อการควบคุม เป็นต้น สัญญาณควบคุมดังกล่าวจะไปสั่ง รีเลย์ เพื่อให้สามารถรับกระแสได้มากขึ้นและเพิ่มสถานะการควบคุมเพิ่มขึ้นคือจะให้ทำงานที่ปกติเปิดหรือปกติปิด ก็ได้

ชุดอุปกรณ์ทั้งหมด จะถูกควบคุมอีกครั้งจาก แผงควบคุมของผู้ป่วยเมื่อผู้ป่วยกด ปุ่มฉุกเฉินระบบจะทำการยกเลิกการทำงานทุกจุดและสลับให้มอเตอร์หมุนคลายเชือกออกพร้อมกับสั่งให้สัญญาณดังขึ้น

อุปกรณ์ที่ใช้สร้างทั้งหมด จะหลีกเลี่ยงอุปกรณที่สร้างได้ยาก หรืออุปกรณ์พิเศษใดๆ แต่จะเน้นที่อุปกรณ์ที่หาได้ตามท้องตลาด ร้านขายวัสดุก่อสร้าง สั่งได้จาก Internet ร้านขายอุปกรณ์อิเล็คโทรนิกส์ สร้างได้ตามโรงกลึงพื้นๆ และสามารถใช้อุปกรณ์อื่นๆ ทดแทนได้ตามที่จะหาได้ มีความต้องการความแม่นยำในการสร้างต่ำซึ่งจะทำให้ราคาสร้างถูกลง

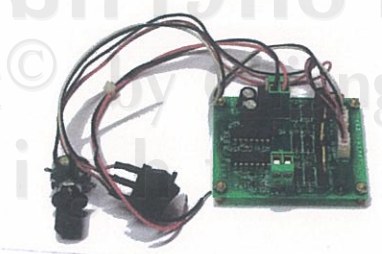


รูปที่ 8 แสดงรายละเอียดของระบบต่างๆ ทั้งหมด

ผลการประดิษฐ์สร้างเครื่องดึงคอ

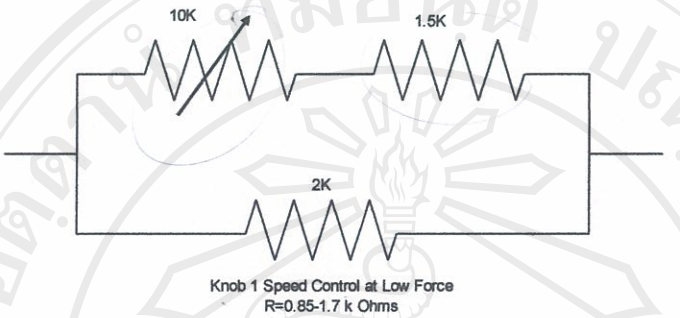
ระบบควบคุมความเร็วและทิศทาง (Speed and Direction Control System)

การควบคุมมอเตอร์ สามารถหาวงจรควบคุมความเร็ว ได้ทั่วไปในท้องตลาด อย่างไรก็ตาม ต้องควบคุมให้การหมุนคงที่เมื่อมีแรงดึงเพิ่มมากขึ้น ส่วนทิศทางการหมุนนั้นสามารถทำได้โดยง่าย คือสลับขั้วไฟฟ้า ทิศทางการหมุนของมอเตอร์ ก็จะเปลี่ยนไป เพราะเป็นมอเตอร์กระแสตรง อย่างไรก็ตาม ในตัวอุปกรณ์ควบคุมความเร็วนั้น มีปุ่มปรับทิศทางอยู่ เพื่อสะดวกต่อการใช้ ดังรูปที่ 9



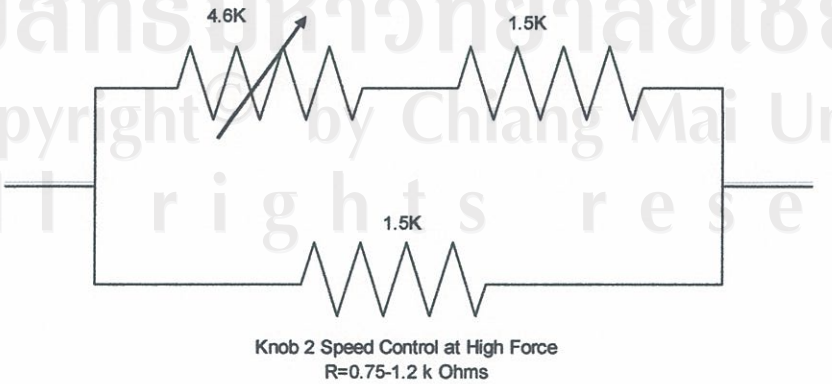
รูปที่ 9 แสดงวงจรควบคุมความเร็วและทิศทาง

ในการควบคุมความเร็วของตัวควบคุมทำโดยปรับตัวต้านทานที่เปลี่ยนค่าได้ หากมีค่าความต้านทานสูงมอเตอร์จะหมุนเร็วขึ้นและมอเตอร์จะหยุดหากค่าความต้านทานเป็นศูนย์ เพื่อให้สามารถปรับได้ละเอียดขึ้น และป้องกันอันตรายจึงทำการแก้ไขดัดแปลงแยกตัวต้านทาน ออกเป็น 2 ชุด เพื่อให้ควบคุมความเร็วเมื่อแรงมากขึ้น โดยชุดแรกจะใช้เมื่อตอนเริ่มดึงจนถึงระดับแรงที่กำหนดจะสลับไปใช้ชุดที่ 2 แทน ชุดแรกจะต่อความต้านทางเพิ่ม ดังรูปที่ 10



รูปที่ 10 แสดงวงจรของตัวต้านทานชุดที่ 1

ตัวต้านทานชุดที่ 2 จะควบคุมในขณะที่แรงดึงสูง เพื่อลดความเร็วในการดึงให้ช้าลง ป้องกันการกระชาก โดยจะทำการควบคุมไม่ให้ความต้านทานเกิน 1.2 kOhm ซึ่งเป็นค่าที่ทดลองแล้วทำให้แรงดึงเชือกดึงได้สูงสุดไม่เกิน 25 kgf ดังรูปที่ 11



รูปที่ 11 แสดงวงจรของตัวต้านทานชุดที่ 2

การควบคุมแรงในเชือก

แรงดึงในเชือกจะถูกวัดโดยตัววัดแรงและแปลงค่าเป็นตัวเลขโดยใช้จอแสดงผล (Indicator display) ดังรูปที่ 12

รูปที่ 12 แสดงตัววัดแรงและจอแสดงผล

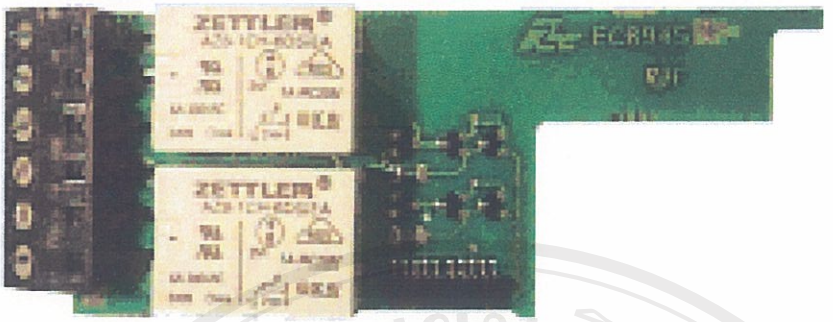
ค่าที่วัดจะถูกควบคุมโดยการปรับตั้งค่า Set Point 4 ค่า คือ SP1-SP4

SP1 คือจุดที่แรงต่ำสุดเมื่อถอยกลับ เครื่องจะหยุดถอยกลับและไม่อนุญาตให้ถอยกลับ

SP2 คือจุดที่แรงดึงสูงสุดที่ให้ขึ้นไปถึงโดยเครื่องจะหยุดดึง และไม่อนุญาตให้ดึงต่อไป

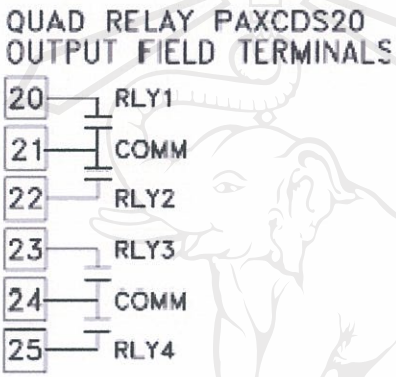
SP3 คือแรงดึงของเส้นเชือก โดยเป็นตัวตรวจสอบว่าเชือกไม่หย่อน หรือหลุด หากเชือกหย่อนหรือไม่มีแรงดึง เครื่องจะหยุดทันทีเพื่อกันเชือกพันกัน ค่าที่ตั้งประมาณ 0.2-0.5 kg ห้ามตั้งเป็นศูนย์เพราะจะทำให้ระบบเปิด ปิด สลับไปมา

SP4 คือจุดควบคุมความเร็ว โดยระบบจะมีการควบคุมความเร็วอยู่ 2 ระดับ โดยการควบคุมของปุ่มปรับ 2 ชุด ในการดึงในช่วงแรก การควบคุมของปุ่มปรับที่ 1 จะดึงด้วยความเร็วสูงถึงปานกลาง เพื่อดึงเชือกให้ตึงและลดเวลา ในการดึงในช่วงที่สอง การควบคุมของปุ่มปรับที่ 2 จะดึงด้วยความเร็วที่ช้าถึงช้ามาก เพื่อลดความเร็วเมื่อแรงมากขึ้น ควรตั้งไว้ที่ 3-5 กก. เมื่อแรงดึงถึงค่าที่ตั้งเครื่องจะสั่งไปที่รีเลย์ของ Module PAXCDS20 โดย Module ดังกล่าวจะเป็นรุ่นที่เป็น 4 รีเลย์ ดังรูปที่ 13



รูปที่ 13 แสดง Module PAXCDS20

เนื่องจากรีเลย์ทุกตัว จะมีผลลัพธ์เดียว และรีเลย์ 2 ตัวจะมี Common ร่วมดังรูปที่ 14



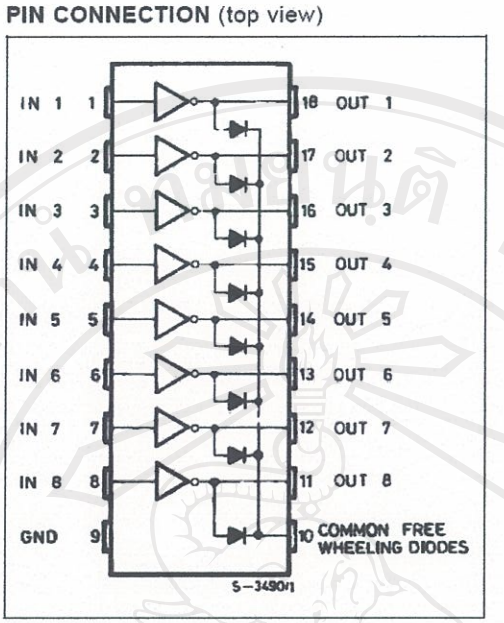
รูปที่ 14 แสดงขั้วขาออกของรีเลย์

ดังนั้นการตั้งค่าให้เป็นปกติเปิด (Normally Open, NO) หรือปกติปิด (Normally Close, NC) จึงไม่สะดวกนักและเนื่องจาก Module ราคาแพง และรับแรงได้ไม่มากนัก จึงจำเป็นที่จะต้องนำไปต่อรีเลย์ภายนอกที่ถูกกว่ามากอีกที หากรีเลย์ภายนอก เกิดเสียหายเนื่องกระแสเกินก็เปลี่ยนได้ง่าย

ปุ่มฉุกเฉิน (Emergency Switch)

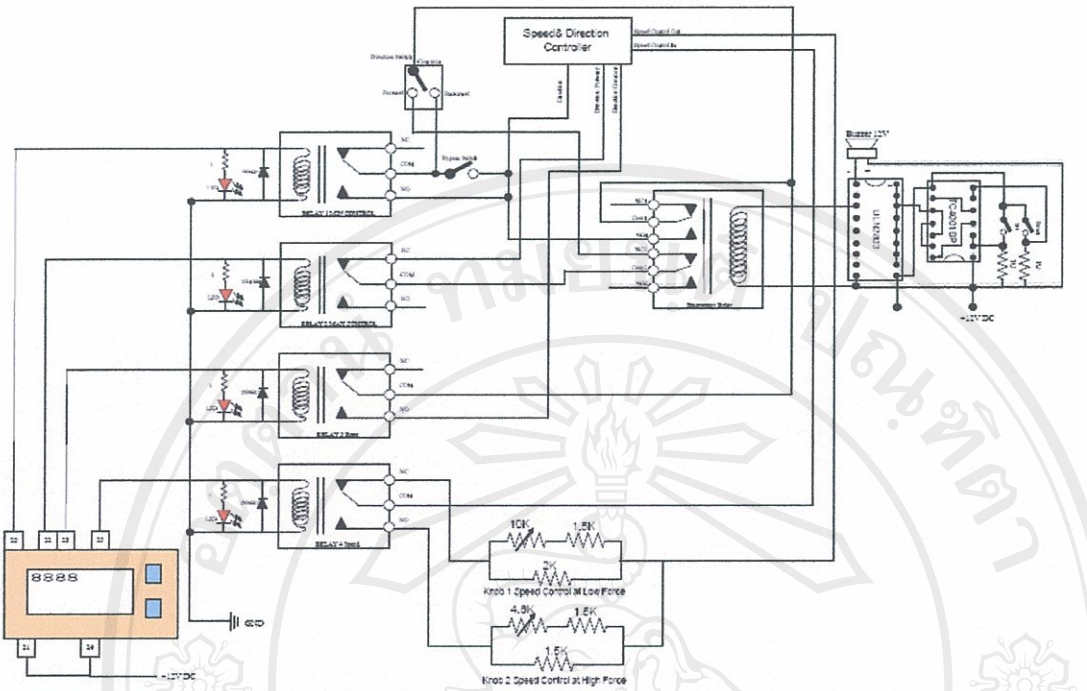
สำหรับปุ่มฉุกเฉินนั้น จะต่อโดยใช้ Logical Gate IC โดยทำหน้าที่เมื่อผู้ป่วยกดสวิตช์แล้วระบบจะสลับให้เครื่องเดินถอยกลับจนกว่าแรงจะลดลงจนกระทั่งถึงระดับปลอยภัย และหยุดค้างอยู่แบบนั้น จนกว่าจะกดสวิตช์ Reset ซึ่งทำได้โดยใช้ RS Flip-Flop IC หรืออาจต่อโดยใช้ NAND หรือ NOR Gate แทนก็ได้ซึ่งจำต้อง ปรับวงจรใหม่ Logical Gate ใช้แบบ TTL หรือ CMOS ก็ได้ อย่างไรก็ตามที่นี้ใช้ CMOS แบบ NOR เบอร์ TC4001 ซึ่งหาง่ายและ ใช้ไฟเลี้ยง 12V ได้เลย ซึ่งทำให้ไม่ต้องแปลงไฟอีก

สัญญาณดังกล่าวจะนำไปต่อ IC ULN2803 ซึ่งเป็นวงจร 8 Darlington Transistors ดังรูปที่ 15 ซึ่งใช้เพื่อนำไปขับรีเลย์ สำหรับตัดการดึงและบัสเซอร์ (Buzzer) เพื่อส่งสัญญาณเตือน

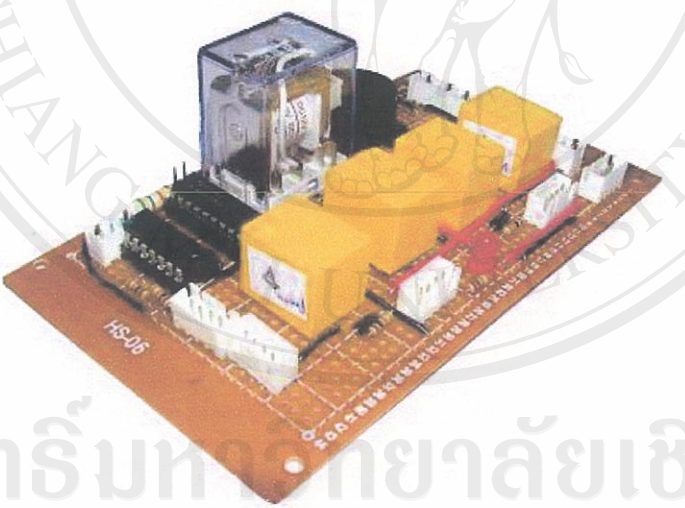


รูปที่ 15 แสดง IC ULN2803

วงจรควบคุมตามรูปที่ 16 จะถูกต่อ รวมกันเป็นแผงวงจรดังรูป ดังรูปที่ 17



รูปที่ 16 แสดงการต่ออุปกรณ์ต่างๆ ในแผงวงจรควบคุม



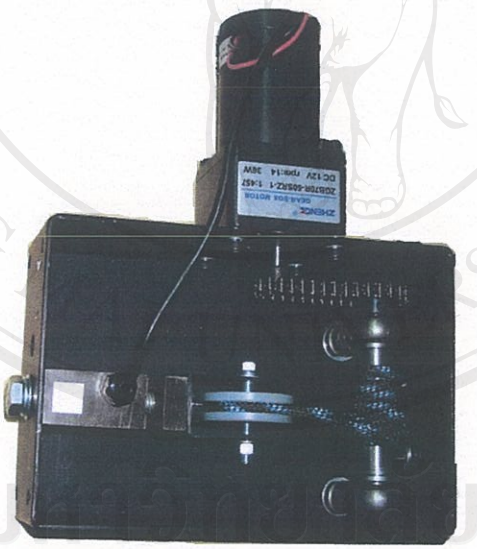
รูปที่ 17 แสดงแผงวงจรควบคุม

มอเตอร์และชุดขับ

มอเตอร์จะใช้มอเตอร์ DC 12V, 14rpm, 36W อัตราทด 1:457 และต่อเข้ากับชุดเฟือง โซ่ DID 25H-82L และ ตุ๊กตาแบริ่ง เพื่อเพิ่มแรงและลดรอบลง ดังรูปที่ 18

รูปที่ 18 แสดงมอเตอร์ DC 12V, 14rpm, 36W อัตราทด 1:457

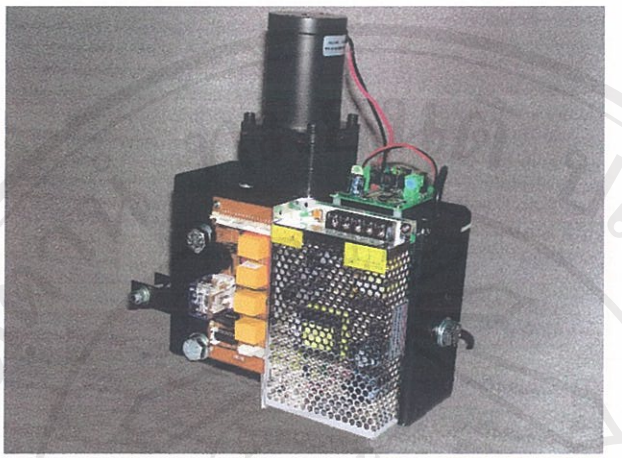
ชุดขับดังกล่าวจะถูกประกอบเข้ากับตัวถัง ดังรูปที่ 19 เชือกที่ใช้เพื่อดึงจะต้องเป็นเชือกพิเศษที่ทนต่อแรงดึงสูง และมีความอ่อนตัวเพียงพอ เพื่อให้เกิดความยืดหยุ่นที่พอดีเพื่อป้องกันการกระชาก จากการดึงไปสู่ผู้ป่วย และจะทำให้แรงดึงค่อยๆเพิ่มขึ้นทีละน้อย โดยเชือกจะใช้ขนาด 5 mm มีขนาด Break Force ที่ 150 kgf โดยปกติจะใช้เชือกปีนเขาก็ได้ แต่ไม่ใช้เชือกที่ใช้กับการช่วยชีวิตเพราะเชือกเหล่านั้นไม่มีความยืดหยุ่นพอ



รูปที่ 19 แสดงการประกอบตัวถัง มอเตอร์ ชุดเฟือง และตัววัดแรง

การประกอบรวม

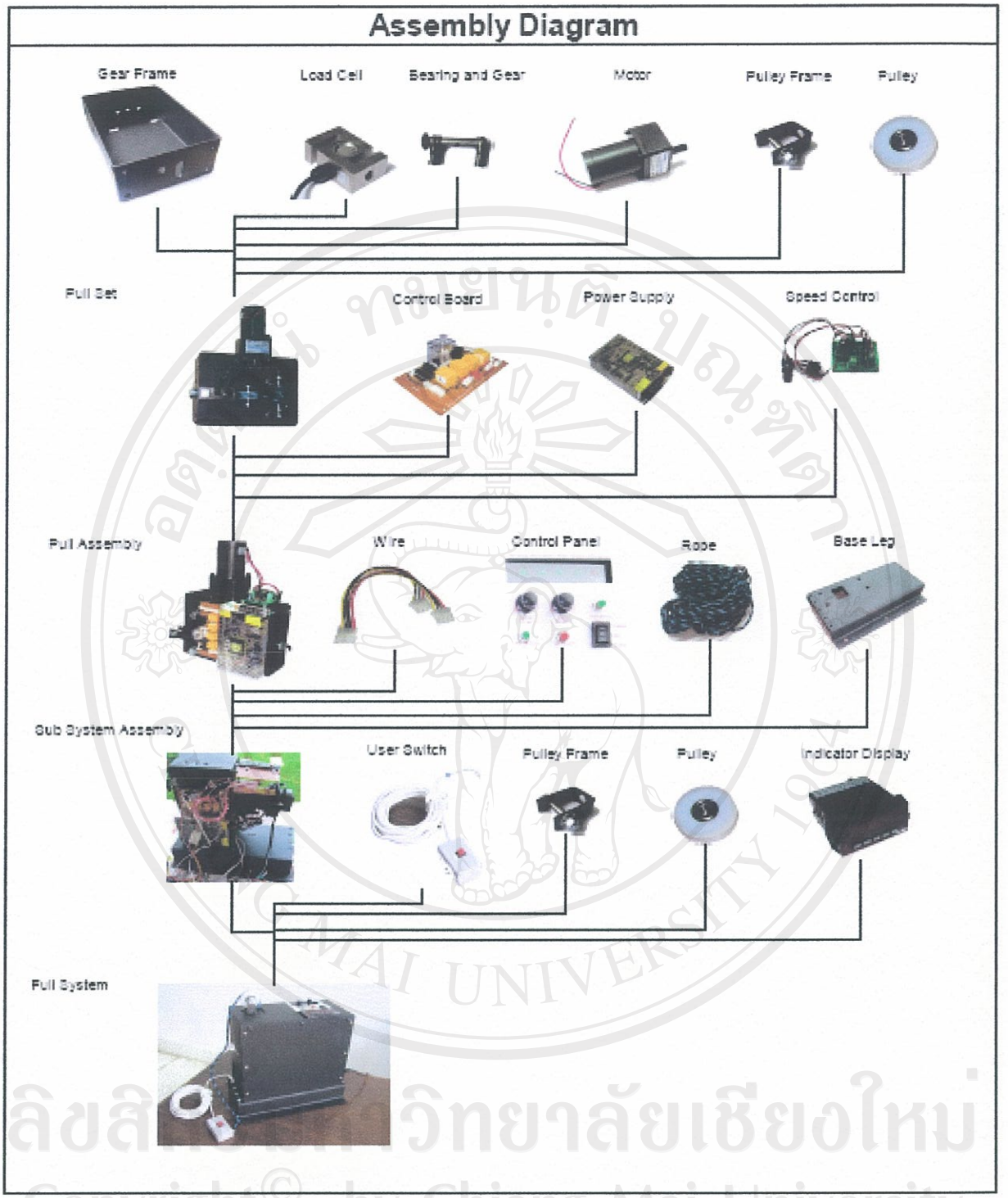
อุปกรณ์ทุกชิ้นจะถูกประกอบรวมกันทั้งหมด ตั้งแต่ วงจรแผงควบคุม แผงควบคุมความเร็ว ตัววัดแรง แหล่งจ่ายไฟ ตัวแสดงผลต่างๆ เข้าด้วยกันกับตัวถัง ซึ่งทำให้ใช้พื้นที่น้อย ดังรูปที่ 20



รูปที่ 20 แสดงการวางตำแหน่งของอุปกรณ์ต่างๆ

ชุดในรูปที่ 16 ดังกล่าวประกอบกับสายสัญญาณ จอแสดงผล แผงควบคุม และปุ่มฉุกเฉิน โดยครอบด้วยฝาครอบเพื่อความเรียบร้อยดังรูปที่ 21 โดยมีขั้นตอนการประกอบดังรูปที่ 22

รูปที่ 21 แสดงเครื่องดึงคอที่ประกอบสมบูรณ์



รูปที่ 22 แสดงขั้นตอนการประกอบชิ้นส่วน

ผลการทดสอบทางวิศวกรรม

จากการทดสอบแนวความคิดกับต้นแบบเบื้องต้น (ดังรูปที่ 23) และเครื่องที่สมบูรณ์แล้ว และพบว่าเครื่องสามารถทำงานได้ตามต้องการ โดยมีข้อมูลตามตารางที่ 1

รูปที่ 23 แสดงการทดสอบแนวความคิดต้นแบบเบื้องต้น

ตารางที่ 1 แสดงผลการทดสอบทางวิศวกรรม

ลำดับ	หัวข้อ	ผล
1	แรงดึงสูงสุดที่สามารถดึงได้	70 กก.*
2	แรงปกติที่ใช้งาน	0-25 กก.
3	ความผิดพลาดจากการวัดน้ำหนักคงที่	< 0.02 กก.
4	ความเร็วในการดึง	2 เมตร/ นาที
5	ความผิดพลาดในการควบคุมที่แรงสูงสุด	0.1 กก.
6	ความผิดพลาดในการควบคุมที่แรงต่ำสุด	0.5 กก.
7	ช่วงกระตุ้นการทำงานใหม่เมื่อแรงดึงลดลงจากจุดสูงสุด	0.2 กก.

* หากใช้แรงสูงต้องเปลี่ยนรอก ระบบได้ออกแบบให้ใช้แรงได้เพียง 25 กก. เพื่อความปลอดภัย

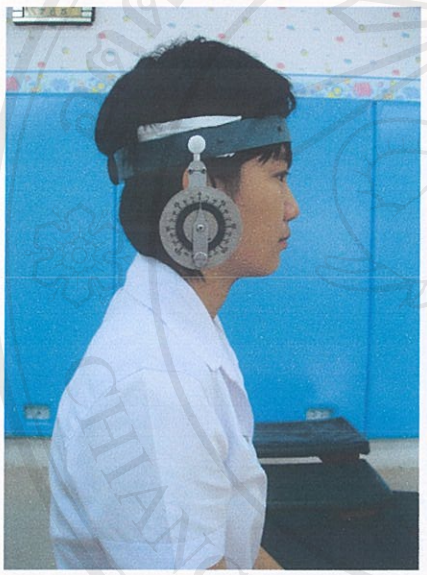
ผลการทดสอบการนำไปใช้ในทางคลินิก

การทดสอบการใช้งานทางคลินิคทำในผู้ป่วยที่มีอาการปวดคอ จำนวน 3 คน เป็นชาย 1 คน หญิง 2 คน โดยทำการซักประวัติและตรวจร่างกาย

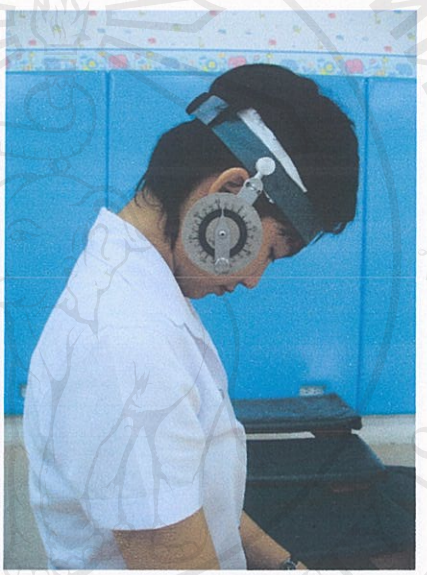
การซักประวัติ

เพื่อหาสาเหตุของปัญหา ระยะเวลาของการดำเนินของโรค ค้นหากิกรรมอะไรที่ทำแล้วอาการดีขึ้น และแย่ลง พฤติกรรมของอาการปวด รวมถึงข้อบ่งชี้ ข้อห้าม ข้อควรระวัง ของการดึงคอด้วยเครื่อง

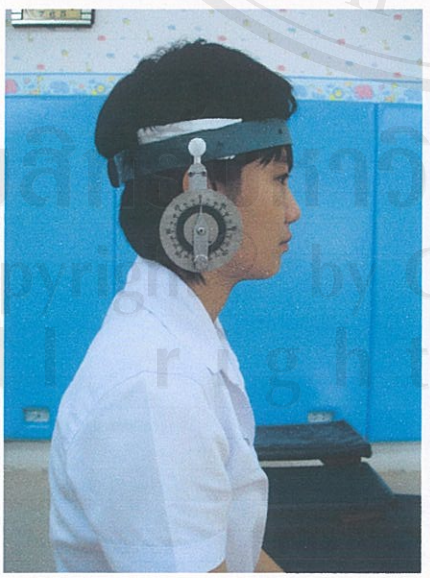
การตรวจประเมินองศาการเคลื่อนไหวด้วยเครื่อง Inclinometer



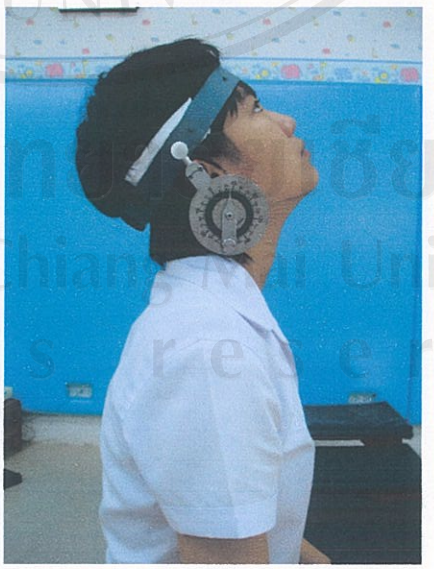
Neutral



Flexion



Neutral



Extension

Neutral

Lateral flexion

Neutral

Rotation

รูปที่ 24 แสดงการตรวจประเมินองศาการเคลื่อนไหวของคอ

การตรวจประเมินความรู้สึกเจ็บปวดโดยการทำเครื่องหมายลงบน Visual analog scale

ไม่ปวดเลย ปวดมากที่สุดจนทนไม่ไหว

ผลการศึกษาพบว่า เครื่องดึงคอที่สร้างขึ้นใหม่นี้สามารถใช้ลดปวดทั้งในขณะพักและขณะที่มีการเคลื่อนไหว ประเมินจากการวัดด้วย visual analog scale นอกจากนี้ องศาการเคลื่อนไหวยังเพิ่มขึ้นทันทีภายหลังการรักษา ประเมินจาก inclinometer เมื่อสัมภาษณ์ความรู้สึกขณะดึงของผู้ป่วยพบว่า ผู้ป่วยรู้สึกว่าเครื่องดึงได้นุ่มนวล ไม่มีการกระตุกใดๆ ทำให้รู้สึกผ่อนคลาย ไม่เกร็งต้าน นอกจากนี้ยังรู้สึกดีที่มีปุ่มฉุกเฉินสำหรับผู้ป่วย ซึ่งผู้ป่วยสามารถหยุดการทำงานของเครื่องหากผู้ป่วยรู้สึกปวด มีอาการชา หรืออาการที่ไม่พึงประสงค์ใดทันที

บทวิจารณ์

จากการดำเนินการตั้งแต่แนวความคิดแรกๆ ใช้กลไกล้วน ซึ่งพบว่าจะเสียค่าใช้จ่ายไปกับโครงสร้างเตียงมากเกินซึ่งไม่ตรงกับ เป้าหมายคือเครื่องดึงคอ นอกจากนั้นยังไม่ง่ายนักหากจะต้องขนย้ายเตียงไปมาซึ่งขัดกับวัตถุประสงค์ที่ต้องเคลื่อนย้ายได้ ดังนั้นโครงสร้างการดึงจึงถูกออกแบบใหม่และมีการใช้อุปกรณ์อิเล็คโทรนิกส์ เพิ่มขึ้นทำให้มีขนาดเล็กลงและทำงานได้ดีกว่าแนวความคิดแรกมาก ด้วยเหตุที่เครื่องดึงคอนี้มีราคาถูกและมีแนวความคิดและกลไกที่ง่าย จึงสามารถที่จะเข้าใจและสร้างได้โดยช่างทั่วๆ ไปที่ไม่ต้องมีความรู้มากนัก

จากการทดลองออกแบบในหลายๆ รูปแบบ จนได้รูปแบบที่ใช้สร้าง ซึ่งจะพบว่ามีข้อดีหลายประการ เช่น เชือกสามารถยืดยาวออกไปได้หลายเมตรและต่อยาวได้ ซึ่งสะดวกต่อการทำงานมากกว่ากลไกแบบตายตัวแบบอื่นๆ นอกจากนี้เชือกยังลดแรกกระชากจากกลไกการขับเคลื่อนอื่นๆ รวมทั้งยังทำให้การวัดแม่นยำ เพราะไม่ขึ้นกับมุมที่ดึง สามารถต่อรอกภายนอกไปยังจุดต่างๆ โดยไม่มีผลต่อการวัดมากนัก แต่ข้อเสียก็คือเรื่องการตกร่องที่รอกซึ่งสามารถป้องกันได้ และการหย่อนของเชือกอาจทำให้เชือกพันกันได้ แต่การออกแบบจะป้องกัน โดยหากเชือกไม่ตึงเครื่องจะไม่ทำงาน แรงเสียดทานจากรอกจะมีผลมากขึ้นหากแรงดึงมากขึ้นและหากรอกผิดจะอ่านค่าผิดได้มาก

กลไกขับเคลื่อนที่เป็นโซ่และเฟืองมีข้อดีก็คือถูกมาก และสามารถแก้ไขอัตราทดได้ง่ายแค่เปลี่ยนจำนวนฟันของเฟือง แต่ข้อเสียคือต้องระวังไม่ให้โซ่หย่อนหรือตกร่อง

อุปกรณ์วัดแรงที่ใช้ตัววัดแรงและจอแสดงผลนั้น สามารถหาง่ายหลายยี่ห้อและมีรูปแบบในการประยุกต์การใช้งานที่หลากหลาย ข้อดีมีหลายประการ เช่น ความแม่นยำและความไวในการตอบสนองสูง ขนาดเล็ก ง่ายต่อความเข้าใจในการใช้งาน สามารถ ปรับแต่งได้โดยง่าย การปรับแต่สามารถกำจัดผลกระทบจากสิ่งต่างๆของระบบให้หมดไปได้เช่นมุมการวัด เพราะเครื่องจะชดเชยให้ถูกต้องตามค่าที่วัดตามที่ปรับแต่งตอนเริ่มต้น นอกจากนี้ส่วนที่เป็น อุปกรณ์เสริมที่ต่อเพิ่มได้ เช่น รีเลย์ หรือ RS232 ทำให้ สามารถนำสัญญาณไปควบคุมอุปกรณ์อื่นหรือต่อเข้าคอมพิวเตอร์ได้

โดยรวมเครื่องที่สร้างสามารถทำงานได้ดี แต่ยังคงต้องมีบางประการที่ต้องปรับปรุงต่อไป เช่นระบบจะดึงที่ความเร็วคงที่แต่ไม่สามารถดึงแบบควบคุมอัตราเร่งได้ และความเร็วแม้ปรับได้ก็ยังทำงานได้ตามแรงดึง 2 ระดับเท่านั้น หากเปลี่ยนเป็น สเต็ปมอเตอร์ และไมโครคอนโทรเลอร์ ก็จะแก้ปัญหาได้ แต่ต้องแลกกับราคาที่แพงขึ้น รวมทั้ง ต้องมีโปรแกรมควบคุม ซึ่งไม่สามารถสร้างเองได้โดยช่างทั่วๆ ไป และมีความจำเป็นในการรักษาไม่มากนัก

ในการทดสอบการใช้งานที่ได้วางแผนไว้เบื้องต้น โดยจะทำการถ่ายภาพทางรังสีนั้นไม่สามารถทำได้ เนื่องจากการยื่นขอจริยธรรมนั้นไม่ผ่านจากทางคณะกรรมการ เนื่องจากการฉายรังสีในคนปกติ มีผลกระทบในทางลบมากกว่าประโยชน์ที่จะได้รับจากงานวิจัย อย่างไรก็ตามการทดสอบการประยุกต์ใช้ทางคลินิกก็สามารถพิสูจน์ถึงประสิทธิภาพการทำงานของเครื่องมือที่สร้าง

ขึ้นใหม่ได้ ผลการทดสอบเป็นไปตามสมมติฐานที่ตั้งไว้ ที่เป็นเช่นนี้เนื่องมาจากผลของการรักษาโดยใช้เครื่องดึงคอมีผลในการช่วยเพิ่มระยะห่างหรือช่องว่างของกระดูกคอ รวมถึงลดแรงกดทับที่กระทำต่อเส้นประสาท นอกจากนี้ยังช่วยให้กล้ามเนื้อที่บริเวณคอคลายตัว กระตุ้นให้เกิดการเคลื่อนไหวของกระดูกคอ เพิ่มการไหลเวียนของเลือดที่บริเวณคอด้วย[1] ถึงแม้ว่าผลการรักษาทันทีภายหลังการดึงคอ จะให้ผลเป็นที่พอใจต่อตัวผู้ป่วยเองแล้ว ผลการรักษษในระยะยาว อาจต้องการการศึกษาเพิ่มเติมต่อไปในอนาคต นอกจากนี้การแก้ปัญหาในผู้ป่วยที่มีอาการปวดคอเป็นการรักษาในองค์รวมที่ต้องอาศัยทั้งการแก้ไขทางด้านท่าทางที่ผิดปกติ รวมถึง การออกกำลังกายเพื่อเพิ่มความแข็งแรงของกล้ามเนื้อร่วมด้วย

บทสรุปและข้อเสนอแนะ

ผลลัพธ์จากการวิจัยนี้ คือเครื่องดึงคอที่ประดิษฐ์ขึ้นจากการออกแบบตามหลักการทางวิศวกรรมเบื้องต้น วัสดุที่ใช้สามารถหาได้ง่ายภายในประเทศ ขนาดกระทัดรัด น้ำหนักเบา และผ่านการทดสอบทางวิศวกรรม รวมถึงสามารถช่วยลดอาการปวดและเพิ่มองศาการเคลื่อนไหวให้กับผู้ป่วยปวดคอได้

ข้อเสนอแนะจากงานวิจัยนี้ มีดังต่อไปนี้

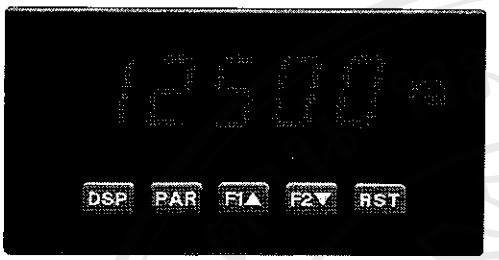
1. เปลี่ยนจากระบบโซ่เป็นระบบเฟือง เพื่อลดขนาด
2. เปลี่ยน DC มอเตอร์ เป็น Stepping มอเตอร์ ที่ควบคุมด้วยไมโครคอลโทรเลอร์หรือคอมพิวเตอร์ เพื่อควบคุมความเร็วได้ทุกระดับความเร็ว และสามารถปรับความเร่งในการดึงได้
3. มอเตอร์สามารถปรับลดขนาดให้เล็กลงแต่ทดรอบมากขึ้น เพื่อลดขนาดและน้ำหนักเครื่องลง เพราะเครื่องไม่ต้องการความเร็วในการดึงสูง
4. เปลี่ยนจอแสดงผล (Indicator panel) เป็นไมโครคอลโทรเลอร์ที่มี A/D converter และใช้ซอฟแวร์ควบคุม การแสดงผลใช้จอ LED สำเร็จรูปแทน ทำให้ราคาลดลงไป 60%
5. สามารถเปลี่ยนรีเลย์ทั้งหมด ให้เป็น IC logical gate แทน เพื่อง่ายต่อการออกแบบวงจรและควบคุมสถานะการต่างๆ รวมถึงราคาถูกกว่าประมาณ 50%
6. เปลี่ยนวงจรรีเลย์ให้เหลือเพียง 2 ตัว โดยใช้ควบคุมทิศทางการเคลื่อนที่และควบคุมการเปิด ปิดมอเตอร์ ส่วนรูปแบบการทำงานใช้ควบคุมโดยซอฟแวร์จากเครื่องคอมพิวเตอร์ โดยขึ้นอยู่กับข้อมูลแรงจากตัววัดแรง
7. เปลี่ยนทุกชิ้นส่วนโครงสร้างจากเหล็กเป็นอลูมิเนียม เพื่อลดน้ำหนัก
8. เปลี่ยนระบบไฟเลี้ยงของจอแสดงผล (Indicator panel) จาก 220 V AC ให้เป็นรุ่น 12 หรือ 24 V DC แทน เพื่อสามารถใช้กับไฟรถยนต์ได้

เอกสารอ้างอิง

1. Kisner C, Colby L.A. The spine: traction procedures. In: Therapeutic exercise: Foundations and techniques. 3rd Edn. Philadelphia: FA Davis Co., 1996 p 575-591
2. DeLeo, J. A. Basic science of pain. J Bone Joint Surg Am. 2006, 88 (2), p 58-62
3. Fryer, G, Morris, T, Gibbons, P. Paraspinal muscles and intervertebral dysfunction: part two. J Manipulative Physiol Ther. 2004, 27 (5), p 348-57
4. Petty, Nicola J. Neuromusculoskeletal examination and assessment : a handbook for therapists. 3rd ed, Edinburgh ; New York : Elsevier Churchill Livingstone, 2006
5. Albert, Todd J. Physical examination of the spine. New York : Thieme, 2005
6. www.redlion.net

ภาคผนวก

MODEL PAXS - SMART STRAIN GAGE METER



- LOAD CELL, PRESSURE AND TORQUE BRIDGE INPUTS
- DUAL RANGE INPUT: ±24 mV OR ±240 mV
- SELECTABLE 5 VDC OR 10 VDC BRIDGE EXCITATION
- OPTIONAL CUSTOM UNITS OVERLAY W/ BACKLIGHT
- PROGRAMMABLE AUTO-ZERO TRACKING
- 16 POINT SCALING FOR NON-LINEAR CORRECTION
- 9 DIGIT TOTALIZER (INTEGRATOR) WITH BATCHING
- PROGRAMMABLE FUNCTION KEYS/USER INPUTS
- PLUG 'N' PLAY FIELD INSTALLABLE OPTION CARDS

UL RECOGNIZED USA | UL RECOGNIZED CANADA | EMC COMPLIANT | NEMA 4X / IP65 | PARAMETER LOCKOUT | PROGRAMMING SOFTWARE | FRONT PANEL PROGRAMMABLE | ALARMS | ANALOG OUTPUT | COMMUNICATIONS CAPABILITY

Click Icon For User Bulletin

FAX/WEB DOC # 04020

Product Features

The PAXS (PAX Strain Gage Input Meter) offers many features and performance capabilities to suit a wide range of industrial applications. The 4½ digit meter employs advanced technology for stable, drift free readout, while incorporating features that provide flexibility now and in the future with Plug-in option cards. The plug-in card options allow the opportunity to configure the meter for present applications, while providing easy upgrades for future needs.

The Strain Gage meter has two bipolar mV input ranges: ± 24 mV DC or ± 240 mV DC. The internal bridge excitation is selectable for 5 VDC or 10 VDC. The excitation output is based on a reference, ensuring accurate and drift-free readouts. A 16 point scaling feature compensates for square-law devices and other non-linear process characteristics.

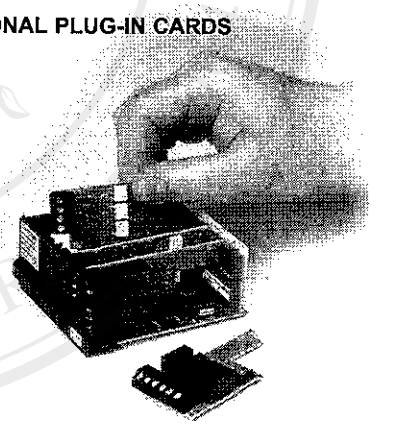
The meter provides a Max and Min reading memory with programmable capture time. The capture time is used to prevent detection of false max and min readings which may occur during start-up or unusual process events.

The signal totalizer (integrator) can be used to compute a time-input product. This can be used to provide a readout of totalized flow, calculate service intervals of motors and pumps, etc. The totalizer can also accumulate batch weighing operations.

Once the meter has been initially configured, the parameter list may be locked out from further modification in its entirety or only the setpoint values can be made accessible.

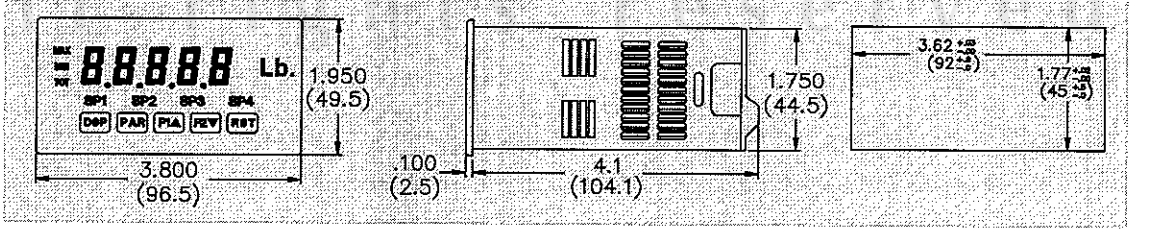
The meter has been specifically designed for harsh industrial environments. With NEMA 4X/IP65 sealed bezel and extensive testing of noise effects to CE requirements, the meter provides a tough yet reliable application solution.

OPTIONAL PLUG-IN CARDS



The PAX series meters can be fitted with up to three optional plug-in cards. However, only one card from each function type can be installed at a time. The function types include Setpoint Alarms (PAXCDS), Communications (PAXCDC), and Analog Output (PAXCDL). The cards can be installed initially or at a later date. Each optional plug-in card is shipped with complete installation and programming instructions.

DIMENSIONS "In inches (mm)"



MODEL PAXS - SMART STRAIN GAGE METER

Product Features Continued

SETPOINT ALARMS PLUG-IN CARDS (PAXCDS)

The PAX series has four setpoint alarm output plug-in cards. Only one of these cards can be installed at a time. (Logic state of the outputs can be reversed in the programming.) These plug-in cards include:

Dual relay, FORM-C, Normally open & closed
Quad relay, FORM-A, Normally open only
Isolated quad sinking NPN open collector
Isolated quad sourcing PNP open collector

The setpoint alarms can be configured in modes to suit a variety of control and alarm requirements.

- High and low absolute, high and low deviation and band acting
- Balanced or unbalanced hysteresis
- On and off delay timers
- Auto reset or latching modes
- Reverse phase output and/or panel indicator
- Selection of alternate list of setpoint values

COMMUNICATION CARDS (PAXCDC)

Plug-in cards also facilitate bus communications. Readout values and setpoint alarm values can be controlled through the bus. Additionally, the meter has features that allow a remote computer to directly control the outputs of the meter. With a communication card installed, it is possible to configure the meter using a Windows® based program. The configuration data can be saved to a file for later recall.

SERIAL RS485 PLUG-IN CARD

An RS485 communication port can be installed with the serial RS485 plug-in card. The RS485 option allows the connection of up to 32 meters or other devices (such as a printer, PLC, HMI, or a host computer) on a single pair of wires not longer than 4,000 feet. The address number of each meter on the line can be programmed from 0-99. Data from the meter(s) can be interrogated or changed and alarm outputs can be reset by sending the proper command string. The function keys and user inputs can be programmed to send data to a printer or other device via serial communications.

SERIAL RS232 PLUG-IN CARD

An RS232 communication port can be installed with the serial RS232 plug-in card. The RS232 is intended to allow only 2 devices, not more than 50 feet apart, to communicate to each other (such as a printer, PLC, HMI, or host computer). Data from the meter(s) can be interrogated or changed and alarm outputs can be reset by sending the proper command string. The function keys and user inputs can be programmed to send data to a printer or device via serial communication.

DEVICENET™ PLUG-IN CARD

A DeviceNet communication port can be installed with the DeviceNet plug-in card. DeviceNet is a high level bus protocol based upon the CAN specifications. The protocol allows the integration of devices of different types and manufacturers within a common communication framework.

ANALOG OUTPUT PLUG-IN CARD (PAXCDL)

Either a 0(4)-20 mA or 0-10 V retransmitted linear DC output is available from the analog output plug-in card. The programmable output low and high scaling can be based on the input, max, min, or total display value. Reverse acting output is possible by reversing the scaling point positions. The output can be scaled independent of the input range. The features of the linear output card are:

- Output tracks either input, totalizer, max or min readings
- Programmable output update times
- Programmable for forward or reverse acting

UNITS LABEL KIT (PAXLBK)

Each meter has a units indicator with backlighting that can be customized using the Units Label Kit. The backlight is controlled in the programming.See Accessories for details on this kit.

PC SOFTWARE (SFPAX)

The SFPAX is a Windows® based program that allows configuration of the PAX meter from a PC. Using SFPAX makes it easier to program the PAX meter and allows saving the PAX program in a PC file for future use. On-line help is available within the software. A PAX serial plug-in card is required to program the meter using the software.

General Specifications

1. **DISPLAY:** 5 digit, 0.56" (14.2 mm) red LED, (-19999 to 99999)
2. **POWER:**
   AC Versions (PAXS0000):
   AC Power: 85 to 250 VAC, 50/60 Hz, 15 VA
   Isolation: 2300 Vrms for 1 min. to all inputs and outputs.
   DC Versions (PAXS0010):
   DC Power: 11 to 36 VDC, 11 W
   (derate operating temperature to 40° C if operating <15 VDC and three plug-in cards are installed)
   AC Power: 24 VAC,± 10%, 50/60 Hz, 15 VA
   Isolation: 500 Vrms for 1 min. to all inputs and outputs (50 V working).
3. **ANNUNCIATORS:**
   MAX - maximum readout selected
   MIN - minimum readout selected
   TOT - totalizer readout selected, flashes when total overflows
   SP1 - setpoint alarm 1 is active
   SP2 - setpoint alarm 2 is active
   SP3 - setpoint alarm 3 is active
   SP4 - setpoint alarm 4 is active
   Units Label - optional units label backlight
4. **KEYPAD:** 3 programmable function keys, 5 keys total
5. **UPDATE RATES:**
   A/D conversion rate: 20 readings/sec.
   Step response: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)**
   700 msec. max. (digital filter disabled, internal zero correction enabled)**
   Display update rate: 1 to 20 updates/sec.
   Setpoint output on/off delay time: 0 to 3275 sec.
   Analog output update rate: 0 to 10 sec
   Max./Min. capture delay time: 0 to 3275 sec.
6. **BRIDGE EXCITATION:**
   Jumper Selectable: 5 VDC @ 65 mA max., ±2%
   10 VDC @ 125 mA max., ±2%
   Temperature coefficient (ratio metric): 20 ppm/°C max.
7. **TOTALIZER:**
   Time Base: second, minute, hour, or day
   Time Accuracy: 0.01% typical
   Decimal Point: 0 to 0.0000
   Scale Factor: 0.001 to 65.000
   Low Signal Cut-out: -19,999 to 99,999
   Total: 9 digits, display alternates between high order and low order readouts

MODEL PAXS - SMART STRAIN GAGE METER

General Specifications Continued

8. **MEMORY:** Nonvolatile E²PROM retains all programmable parameters and display values.
9. **ENVIRONMENTAL CONDITIONS:**
   Operating Temperature Range: 0 to 50°C (0 to 45°C with all three plug-in cards installed)
   Storage Temperature Range: -40 to 60°C
   Operating and Storage Humidity: 0 to 85% max. relative humidity non-condensing
   Altitude: Up to 2000 meters
10. **CERTIFICATIONS AND COMPLIANCES:**
    SAFETY
    EN 61010-1, IEC 1010-1
    UL Recognized Component, File #E179259
    Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.

    ELECTROMAGNETIC COMPATIBILITY
    Immunity to EN 50082-2
    Emissions to EN 50081-2
11. **CONNECTIONS:** High compression cage-clamp terminal block
    Wire Strip Length: 0.3" (7.5 mm)
    Wire Gauge Capacity: One 14 AWG (2.55 mm) solid, two 18 AWG (1.02 mm) or four 20 AWG (0.61 mm)
12. **CONSTRUCTION:** This unit is rated for NEMA 4X/IP65 indoor use. IP20 Touch safe. Installation Category II, Pollution Degree 2. One piece bezel/case. Flame resistant. Synthetic rubber keypad. Panel gasket and mounting clip included.
13. **WEIGHT:** 10.4 oz. (295 g)

Input Specifications

1. **A/D CONVERTER:** 16 bit resolution ***
2. **DISPLAY MESSAGES:**
   "OLOL" - Appears when measurement exceeds + signal range.
   "ULUL" - Appears when measurement exceeds - signal range
   ". . . ." - Appears when display values exceed + display range.
   "- . . ." - Appears when display values exceed - display range.
3. **CONNECTION TYPE:** 4-wire bridge (differential)
   2-wire (single-ended)
4. **COMMON MODE RANGE (w.r.t. input common):** 0 to +5 VDC
   Rejection: 80 db (DC to 120 Hz)
5. **SENSOR INPUTS:**

Input (Range)	Accuracy* (18 to 28C)	Accuracy* (0 to 50C)	Impedance/ Compliance	Max Continuous Overload	Display Resolution ***
±24 mVDC	0.02% of reading +3 µV	0.07% of reading +4 µV	100 Mohm	30 V	1 µV
±240 mVDC	0.02% of reading +30 µV	0.07% of reading +40 µV	100 Mohm	30 V	10 µV

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85%RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

** The meter periodically (every 12 seconds) imposes a 500 msec delay to compensate for internal zero drift. If the delay affects applications where step response is critical, it can be defeated. Set the display update to 20/sec to disable. In this case, add a zero error of 0.2% FS to the 24 mV input range over the 0 to 50°C span.

*** Nominal Resolution. The internal resolution is the input divided by 65,535.

6. **LOW FREQUENCY NOISE REJECTION:**
   Normal Mode: > 60 dB @ 50 or 60 Hz ±1%, digital filter off
   Common Mode: >100 dB, DC to 120 Hz
7. **USER INPUTS (Logic Level):** Three software defined user inputs, jumper selectable for sink/source logic
   Max. Continuous Input: 30 VDC
   Isolation To Sensor Input Common: Not isolated
   Response Time: 50 msec. max.
   Logic State: Jumper selectable for sink/source logic.

INPUT STATE	SINKING INPUTS 22 KΩ pull-up to +5 V	SOURCING INPUTS 22 KΩ pull-down
Active	V_{IN} < 0.7 VDC	V_{IN} > 2.5 VDC
Inactive	V_{IN} > 2.5 VDC	V_{IN} < 0.7 VDC

8. **CUSTOM LINEARIZATION:**
   Data Point Pairs: Selectable from 2 to 16
   Display Range: -19,999 to 99,999
   Decimal Point: 0 to 0.0000

Output Specifications

1. **SERIAL COMMUNICATIONS CARD:**
   Type: RS485 or RS232
   Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
   Working Voltage: 50 V. Not Isolated from all other commons.
   Data: 7/8 bits
   Baud: 300 to 19,200
   Parity: no, odd or even
   Bus Address: Selectable 0 to 99, Max. 32 meters per line (RS485)
   Transmit Delay: Selectable for 2 to 50 msec or 50 to 100 msec (RS485)
2. **DEVICENET™ CARD:**
   Compatibility: Group 2 Server Only, not UCMM capable
   Baud Rates: 125Kbaud, 250 Kbaud, and 500 Kbaud
   Bus Interface: Phillips 82C250 or equivalent with MIS wiring protection per DeviceNet™ Volume I Section 10.2.2.
   Node Isolation: Bus powered, isolated node
   Host Isolation: 500 Vrms for 1 minute (50V working) between DeviceNet™ and meter input common.
3. **ANALOG OUTPUT CARD:**
   Types: 0 to 20 mA, 4 to 20 mA or 0 to 10 VDC
   Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
   Working Voltage: 50 V. Not Isolated from all other commons.
   Accuracy: 0.17% of FS (18 to 28°C); 0.4% of FS (0 to 50°C)
   Resolution: 1/3500
   Compliance: 10 VDC: 10 KΩ load min., 20 mA: 500 Ω load max.
   Update time: 200 msec. max. to within 99% of final output value (digital filter and internal zero correction disabled)
   700 msec. max. (digital filter disabled, internal zero correction enabled)
4. **SETPOINT OUTPUT CARD:** Four types of field installable plug-in cards
   Dual Relay Card:
   Type: Two FORM-C relays
   Isolation To Sensor & User Input Commons: 2000 Vrms for 1 min.

red lion
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion.net

Bulletin No. PAX-G
Drawing No. LP0545
Released 8/07

MODEL PAX – 1/8 DIN ANALOG INPUT PANEL METERS

- *PROCESS, VOLTAGE, CURRENT, TEMPERATURE, AND STRAIN GAGE INPUTS*
- *5-DIGIT 0.56" RED SUNLIGHT READABLE DISPLAY*
- *VARIABLE INTENSITY DISPLAY*
- *16 POINT SCALING FOR NON-LINEAR PROCESSES*
- *PROGRAMMABLE FUNCTION KEYS/USER INPUTS*
- *9 DIGIT TOTALIZER (INTEGRATOR) WITH BATCHING*
- *OPTIONAL CUSTOM UNITS OVERLAY W/BACKLIGHT*
- *FOUR SETPOINT ALARM OUTPUTS (W/OPTION CARD)*
- *COMMUNICATION AND BUS CAPABILITIES (W/OPTION CARD)*
- *RETRANSMITTED ANALOG OUTPUT (W/OPTION CARD)*
- *CRIMSON PROGRAMMING SOFTWARE*
- *NEMA 4X/IP65 SEALED FRONT BEZEL*

C

GENERAL DESCRIPTION

The PAX Analog Panel Meters offer many features and performance capabilities to suit a wide range of industrial applications. Available in five different models to handle various analog inputs, including DC Voltage/Current, AC Voltage/Current, Process, Temperature, and Strain Gage Inputs. Refer to pages 4 through 6 for the details on the specific models. The optional plug-in output cards allow the opportunity to configure the meter for present applications, while providing easy upgrades for future needs.

The meters employ a bright 0.56" LED display. The unit is available with a red sunlight readable or a standard green LED. The intensity of display can be adjusted from dark room applications up to sunlight readable, making it ideal for viewing in bright light applications.

The meters provide a MAX and MIN reading memory with programmable capture time. The capture time is used to prevent detection of false max or min readings which may occur during start-up or unusual process events.

The signal totalizer (integrator) can be used to compute a time-input product. This can be used to provide a readout of totalized flow, calculate service intervals of motors or pumps, etc. The totalizer can also accumulate batch weighing operations.

The meters have four setpoint outputs, implemented on Plug-in option cards. The Plug-in cards provide dual FORM-C relays (5A), quad FORM-A (3A), or either quad sinking or quad sourcing open collector logic outputs. The setpoint alarms can be configured to suit a variety of control and alarm requirements.

Communication and Bus Capabilities are also available as option cards. These include RS232, RS485, Modbus, DeviceNet, and Profibus-DP. Readout values and setpoint alarm values can be controlled through the bus. Additionally, the meters have a feature that allows a remote computer to directly control the outputs of the meter. With an RS232 or RS485 card installed, it is possible to configure the meter using a Windows® based program. The configuration data can be saved to a file for later recall.

A linear DC output signal is available as an optional Plug-in card. The card provides either 20 mA or 10 V signals. The output can be scaled independent of the input range and can track either the input, totalizer, max or min readings.

Once the meters have been initially configured, the parameter list may be locked out from further modification in its entirety or only the setpoint values can be made accessible.

The meters have been specifically designed for harsh industrial environments. With NEMA 4X/IP65 sealed bezel and extensive testing of noise effects to CE requirements, the meter provides a tough yet reliable application solution.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in this literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

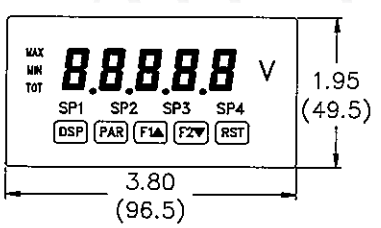
Do not use this unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the unit.

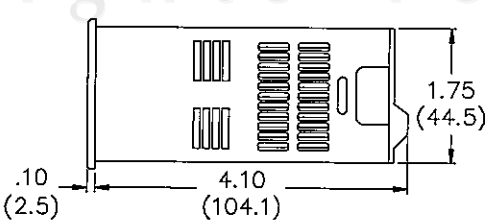
CAUTION: Risk of Danger
Read complete instructions prior to installation and operation of the unit.

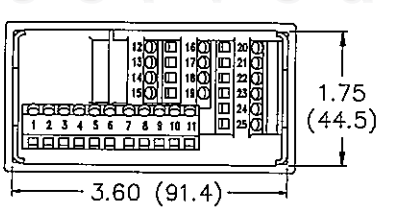
CAUTION: Risk of electric shock.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.4) H x 5.0" (127) W.







MODEL PAXS - SMART STRAIN GAGE METER

Output Specifications Continued

Working Voltage: 240 Vrms
Contact Rating:
One Relay Energized: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @120 VAC, inductive load
Total current with both relays energized not to exceed 5 amps
Life Expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

Quad Relay Card:
Type: Four FORM-A relays
Isolation To Sensor & User Input Commons: 2300 Vrms for 1 min.
Working Voltage: 250 Vrms
Contact Rating:
One Relay Energized: 3 amps @ 250 VAC or 30 VDC (resistive load), 1/10 HP @120 VAC, inductive load
Total current with all four relays energized not to exceed 4 amps
Life Expectancy: 100K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

Quad Sinking Open Collector Card:
Type: Four isolated sinking NPN transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Rating: 100 mA max @ V_{SAT} = 0.7 V max. V_{MAX} = 30 V
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

Quad Sourcing Open Collector Card:
Type: Four isolated sourcing PNP transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V Not Isolated from all other commons.
Rating: Internal supply: 24 VDC ± 10% , 30 mA max. total
External supply: 30 VDC max., 100 mA max. each output
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

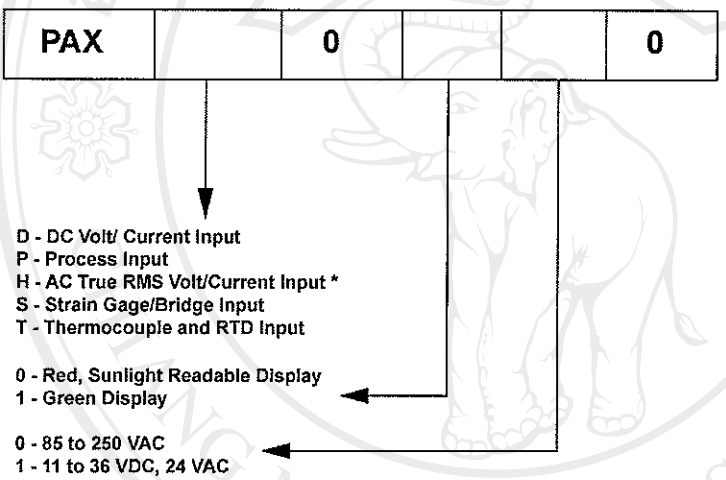
Ordering Information

TYPE	MODEL NO.	DESCRIPTION	PART NUMBERS
Meter	PAXS	Strain Bridge Input Panel Meter, Upgradeable, AC Powered	PAXS0000
		Strain Bridge Input Panel Meter, Upgradeable, DC Powered	PAXS0010
Optional Plug-In Cards	PAXCDS	Dual Setpoint Relay Output Card	PAXCDS10
		Quad Setpoint Relay Output Card	PAXCDS20
		Quad Setpoint Sinking Open Collector Output Card	PAXCDS30
		Quad Setpoint Sourcing Open Collector Output Card	PAXCDS40
	PAXCDC	RS485 Serial Communications Card	PAXCDC10
		RS232 Serial Communications Card	PAXCDC20
		DeviceNET Communications Card	PAXCDC30
	PAXCDL	Analog Output Card	PAXCDL10
Accessories	PAXLBK	Units Label Kit Accessory	PAXLBK10
	SFPAX	PC Configuration Software for Windows 3.x and 95 (3.5" disk)	SFPAX

TABLE OF CONTENTS

ORDERING INFORMATION

Meter Part Numbers



* PAXH is only available with 85-250 VAC power supply.

Option Card and Accessories Part Numbers

TYPE	MODEL NO.	DESCRIPTION	PART NUMBERS
Optional Plug-In Cards	PAXCDS	Dual Setpoint Relay Output Card	PAXCDS10
		Quad Setpoint Relay Output Card	PAXCDS20
		Quad Setpoint Sinking Open Collector Output Card	PAXCDS30
		Quad Setpoint Sourcing Open Collector Output Card	PAXCDS40
	PAXCDC	RS485 Serial Communications Output Card with Terminal Block	PAXCDC10
		Extended RS485 Serial Communications Output Card with Dual RJ11 Connector	PAXCDC1C
		RS232 Serial Communications Output Card with Terminal Block	PAXCDC20
		Extended RS232 Serial Communications Output Card with 9 Pin D Connector	PAXCDC2C
		DeviceNet Communications Card	PAXCDC30
		Modbus Communications Card	PAXCDC40
		Extended Modbus Communications Card with Dual RJ11 Connector	PAXCDC4C
		Profibus-DP Communications Card	PAXCDC50
	PAXCDL	Analog Output Card	PAXCDL10
Accessories	PAXLBK	Units Label Kit Accessory (Not required for PAXT)	PAXLBK10
	SFCRD*	Crimson 2 PC Configuration Software for Windows 98, ME, 2000 and XP	SFCRD200

Crimson software is available for download from http://www.redlion.net/

GENERAL METER SPECIFICATIONS

1. **DISPLAY**: 5 digit, 0.56" (14.2 mm) red sunlight readable or standard green LEDs, (-19999 to 99999)
2. **POWER**:
   AC Versions:
   AC Power: 85 to 250 VAC, 50/60 Hz, 15 VA
   Isolation: 2300 Vrms for 1 min. to all inputs and outputs.
   DC Versions (Not available on PAXH):
   DC Power: 11 to 36 VDC, 11 W
   (derate operating temperature to 40° C if operating <15 VDC and three plug-in option cards are installed)
   AC Power: 24 VAC, ± 10%, 50/60 Hz, 15 VA
   Isolation: 500 Vrms for 1 min. to all inputs and outputs (50 V working).
3. **ANNUNCIATORS**:
   MAX - maximum readout selected
   MIN - minimum readout selected
   TOT - totalizer readout selected, flashes when total overflows
   SP1 - setpoint alarm 1 is active
   SP2 - setpoint alarm 2 is active
   SP3 - setpoint alarm 3 is active
   SP4 - setpoint alarm 4 is active
   Units Label - optional units label backlight
4. **KEYPAD**: 3 programmable function keys, 5 keys total
5. **A/D CONVERTER**: 16 bit resolution
6. **UPDATE RATES**:
   A/D conversion rate: 20 readings/sec.
   Step response: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
   700 msec. max. (digital filter disabled, internal zero correction enabled)
   PAXH Only: 1 sec max. to within 99% of final readout value (digital filter disabled)
   Display update rate: 1 to 20 updates/sec.
   Setpoint output on/off delay time: 0 to 3275 sec.
   Analog output update rate: 0 to 10 sec
   Max./Min. capture delay time: 0 to 3275 sec.
7. **DISPLAY MESSAGES**:
   "OLOL" - Appears when measurement exceeds + signal range.
   "ULUL" - Appears when measurement exceeds - signal range
   PAXT: "SHrt" - Appears when shorted sensor is detected. (RTD only)
   PAXT: "OPEN" - Appears when open sensor is detected
   ". . ." - Appears when display values exceed + display range.
   "- . . ." - Appears when display values exceed - display range.
8. **INPUT CAPABILITIES**: See specific product specifications, pages 4-6
9. **EXCITATION POWER**: See specific product specifications, pages 4-6
10. **LOW FREQUENCY NOISE REJECTION**: (Does not apply to PAXH)
    Normal Mode: > 60 dB @ 50 or 60 Hz ±1%, digital filter off
    Common Mode: >100 dB, DC to 120 Hz
11. **USER INPUTS**: Three programmable user inputs
    Max. Continuous Input: 30 VDC
    Isolation To Sensor Input Common: Not isolated. (Not PAXH)
    PAXH: Isolation to Sensor Input Common: 1400 Vrms for 1 min.
    Working Voltage: 125 V
    Response Time: 50 msec. max.
    Logic State: Jumper selectable for sink/source logic

INPUT STATE	SINKING INPUTS 22 KΩ pull-up to +5 V	SOURCING INPUTS 22 KΩ pull-down
Active	V_{IN} < 0.9 VDC	V_{IN} > 3.6 VDC
Inactive	V_{IN} > 3.6 VDC	V_{IN} < 0.9 VDC

12. **TOTALIZER**:
    Function:
    Time Base: second, minute, hour, or day
    Batch: Can accumulate (gate) input display from a user input
    Time Accuracy: 0.01% typical
    Decimal Point: 0 to 0.0000
    Scale Factor: 0.001 to 65.000
    Low Signal Cut-out: -19,999 to 99,999
    Total: 9 digits, display alternates between high order and low order readouts
13. **CUSTOM LINEARIZATION**:
    Data Point Pairs: Selectable from 2 to 16
    Display Range: -19,999 to 99,999
    Decimal Point: 0 to 0.0000
    PAXT: Ice Point Compensation: user value (0.00 to 650.00 µV/°C)
14. **MEMORY**: Nonvolatile E^2PROM retains all programmable parameters and display values.
15. **ENVIRONMENTAL CONDITIONS**:
    Operating Temperature Range: 0 to 50°C (0 to 45°C with all three plug-in cards installed)
    Vibration According to IEC 68-2-6: 5 to 150 Hz, in X, Y, Z direction for 1.5 hours, 2g's.
    Shock According to IEC 68-2-27: Operational 25 g (10g relay), 11 msec in 3 directions.
    Storage Temperature Range: -40 to 60°C
    Operating and Storage Humidity: 0 to 85% max. RH non-condensing
    Altitude: Up to 2000 meters
16. **CERTIFICATIONS AND COMPLIANCES**:
    SAFETY
    UL Recognized Component, File #E179259, UL61010A-1, CSA C22.2 No. 1010-1
    PAXT Only: File # E156876, UL873, CSA C22.2 No. 24
    Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
    UL Listed, File # E137808, UL508, CSA C22.2 No. 14-M95
    LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
    Type 4X Enclosure rating (Face only), UL50
    IECEE CB Scheme Test Certificate #US/8843A/UL
    CB Scheme Test Report #04ME11209-20041018
    Issued by Underwriters Laboratories, Inc.
    IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part I
    IP65 Enclosure rating (Face only), IEC 529
    IP20 Enclosure rating (Rear of unit), IEC 529

    ELECTROMAGNETIC COMPATIBILITY

Immunity to EN 50082-2		
Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m [1] 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms 150 KHz - 80 MHz
Simulation of cordless telephones	ENV 50204	Level 3; 10 V/m 900 MHz ±5 MHz 200 Hz, 50% duty cycle
Emissions to EN 50081-2		
RF interference	EN 55011	Enclosure class A Power mains class A

Notes:
1. Self-recoverable loss of performance during EMI disturbance at 10 V/m: Measurement input and/or analog output signal may deviate during EMI disturbance.
For operation without loss of performance:
Unit is mounted in a metal enclosure (Buckeye SM7013-0 or equivalent)
I/O and power cables are routed in metal conduit connected to earth ground.
Refer to EMC Installation Guidelines section of the bulletin for additional information.

17. **CONNECTIONS**: High compression cage-clamp terminal block
    Wire Strip Length: 0.3" (7.5 mm)
    Wire Gage: 30-14 AWG copper wire
    Torque: 4.5 inch-lbs (0.51 N-m) max.
18. **CONSTRUCTION**: This unit is rated for NEMA 4X/IP65 outdoor use. IP20 Touch safe. Installation Category II, Pollution Degree 2. One piece bezel/case. Flame resistant. Synthetic rubber keypad. Panel gasket and mounting clip included.
19. **WEIGHT**: 10.4 oz. (295 g)

MODEL PAXD - UNIVERSAL DC INPUT

- *FOUR VOLTAGE RANGES (300 VDC Max)*
- *FIVE CURRENT RANGES (2A DC Max)*
- *THREE RESISTANCE RANGES (10K Ohm Max)*
- *SELECTABLE 24 V, 2 V, 1.75 mA EXCITATION*

PAXD SPECIFICATIONS

INPUT RANGES:

INPUT RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE/ COMPLIANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
±200 µADC	0.03% of reading +0.03 µA	0.12% of reading +0.04µA	1.11 Kohm	15 mA	10 nA
±2 mADC	0.03% of reading +0.3 µA	0.12% of reading +0.4 µA	111 ohm	50 mA	0.1 µA
±20 mADC	0.03% of reading +3µA	0.12% of reading +4 µA	11.1 ohm	150 mA	1 µA
±200 mADC	0.05% of reading +30 µA	0.15% of reading +40 µA	1.1 ohm	500 mA	10 µA
±2 ADC	0.5% of reading +0.3 mA	0.7% of reading +0.4 mA	0.1 ohm	3 A	0.1 mA
±200 mVDC	0.03% of reading +30 µV	0.12% of reading +40 µV	1.066 Mohm	100 V	10 µV
±2 VDC	0.03% of reading +0.3 mV	0.12% of reading +0.4 mV	1.066 Mohm	300 V	0.1 mV
±20 VDC	0.03% of reading +3 mV	0.12% of reading +4 mV	1.066 Mohm	300 V	1 mV
±300 VDC	0.05% of reading +30 mV	0.15% of reading +40 mV	1.066 Mohm	300 V	10 mV
100 ohm	0.05% of reading +30 Mohm	0.2% of reading +40 Mohm	0.175 V	30 V	0.01 ohm
1000 ohm	0.05% of reading +0.3 ohm	0.2% of reading +0.4 ohm	1.75 V	30 V	0.1 ohm
10 Kohm	0.05% of reading +1 ohm	0.2% of reading +1.5 ohm	17.5 V	30 V	1 ohm

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85% RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

EXCITATION POWER:

Transmitter Power: 24 VDC, ±5%, regulated, 50 mA max.
Reference Voltage: 2 VDC, ± 2%
Compliance: 1 kohm load min. (2 mA max.)
Temperature coefficient: 40 ppm/°C max.
Reference Current: 1.75 mADC, ± 2%
Compliance: 10 kohm load max.
Temperature coefficient: 40 ppm/°C max.

MODEL PAXP - PROCESS INPUT

- *DUAL RANGE INPUT (20 mA or 10 VDC)*
- *24 VDC TRANSMITTER POWER*

PAXP SPECIFICATIONS

SENSOR INPUTS:

INPUT (RANGE)	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE/ COMPLIANCE	MAX CONTINUOUS OVERLOAD	DISPLAY RESOLUTION
20 mA (-2 to 26 mA)	0.03% of reading +2 µA	0.12% of reading +3 µA	20 ohm	150 mA	1 µA
10 VDC (-1 to 13 VDC)	0.03% of reading +2 mV	0.12% of reading +3 mV	500 Kohm	300 V	1 mV

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85%RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

EXCITATION POWER:

Transmitter Power: 24 VDC, ±5%, regulated, 50 mA max.

MODEL PAXH - AC TRUE RMS VOLT AND CURRENT

- *FOUR VOLTAGE RANGES (300 VAC Max)*
- *FIVE CURRENT RANGES (5 A Max)*
- *ACCEPTS AC OR DC COUPLED INPUTS*
- *THREE WAY ISOLATION: POWER, INPUT AND OUTPUTS*

PAXH SPECIFICATIONS

INPUT RANGES:

⚠ Isolation To Option Card Commons and User Input Commons: 125 Vrms
Isolation To AC Power Terminals: 250 Vrms

INPUT RANGE	ACCURACY*	IMPEDANCE (60 Hz)	MAX CONTINUOUS OVERLOAD	MAX DC BLOCKING	RESOLUTION
200 mV	0.1% of reading +0.4 mV	686 Kohm	30 V	±10 V	0.01 mV
2 V	0.1% of reading +2 mV	686 Kohm	30 V	±50 V	0.1 mV
20 V	0.1% of reading +20 mV	686 Kohm	300 V	±300 V	1 mV
300 V	0.2% of reading +0.3 V	686 Kohm	300 V	±300 V***	0.1 V
200 µA	0.1% of reading +0.4 µA	1.11 Kohm	15 mA	±15 mA	0.01 µA
2 mA	0.1% of reading +2 µA	111 ohm	50 mA	±50 mA	0.1 µA
20 mA	0.1% of reading +20 µA	11.1 ohm	150 mA	±150 mA	1 µA
200 mA	0.1% of reading +0.2 mA	1.1 ohm	500 mA	±500 mA	10 µA
5 A	0.5% of reading +5 mA	0.02 ohm	7 A**	±7 A***	1 mA

*Conditions for accuracy specification:
- 20 minutes warmup
- 18-28°C temperature range, 10-75% RH non-condensing
- 50 Hz - 400 Hz sine wave input
- 1% to 100% of range
- Add 0.1% reading + 20 counts error over 0-50°C range
- Add 0.2% reading + 10 counts error for crest factors up to 3, add 1% reading up to 5
- Add 0.5% reading + 10 counts of DC component
- Add 1% reading + 20 counts error over 20 Hz to 10 KHz range

** Non-repetitive surge rating: 15 A for 5 seconds

*** Inputs are direct coupled to the input divider and shunts. Input signals with high DC component levels may reduce the usable range.

MAX CREST FACTOR (Vp/VRMS): 5 @ Full Scale Input
INPUT COUPLING: AC or AC and DC
INPUT CAPACITANCE: 10 pF
COMMON MODE VOLTAGE: 125 VAC working
COMMON MODE REJECTION: (DC to 60 Hz) 100 dB

MODEL PAXS - STRAIN GAGE INPUT

- *LOAD CELL, PRESSURE AND TORQUE BRIDGE INPUTS*
- *DUAL RANGE INPUT: ±24 mV OR ±240 mV*
- *SELECTABLE 5 VDC OR 10 VDC BRIDGE EXCITATION*
- *PROGRAMMABLE AUTO-ZERO TRACKING*

PAXS SPECIFICATIONS

SENSOR INPUTS:

INPUT RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
±24 mVDC	0.02% of reading +3 µV	0.07% of reading +4 µV	100 Mohm	30 V	1 µV
±240 mVDC	0.02% of reading +30 µV	0.07% of reading +40 µV	100 Mohm	30 V	10 µV

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85% RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

CONNECTION TYPE: 4-wire bridge (differential)
2-wire (single-ended)
COMMON MODE RANGE (w.r.t. input common): 0 to +5 VDC
Rejection: 80 dB (DC to 120 Hz)
BRIDGE EXCITATION :
Jumper Selectable: 5 VDC @ 65 mA max., ±2%
10 VDC @ 125 mA max., ±2%
Temperature coefficient (ratio metric): 20 ppm/°C max.

MODEL PAXT - THERMOCOUPLE AND RTD INPUT

- *THERMOCOUPLE AND RTD INPUTS*
- *CONFORMS TO ITS-90 STANDARDS*
- *CUSTOM SCALING FOR NON-STANDARD PROBES*
- *TIME-TEMPERATURE INTEGRATOR*

PAXT SPECIFICATIONS

READOUT:
Resolution: Variable: 0.1, 0.2, 0.5, or 1, 2, or 5 degrees
Scale: F or C
Offset Range: -19,999 to 99,999 display units

THERMOCOUPLE INPUTS:
Input Impedance: 20 MΩ
Lead Resistance Effect: 0.03μV/ohm
Max. Continuous Overvoltage: 30 V

INPUT TYPE	RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	STANDARD	WIRE COLOR	
					ANSI	BS 1843
T	-200 to 400°C -270 to -200°C	1.2°C **	2.1°C	ITS-90	(+) blue (-) red	(+) white (-) blue
E	-200 to 871°C -270 to -200°C	1.0°C **	2.4°C	ITS-90	(+) purple (-) red	(+) brown (-) blue
J	-200 to 760°C	1.1°C	2.3°C	ITS-90	(+) white (-) red	(+) yellow (-) blue
K	-200 to 1372°C -270 to -200°C	1.3°C **	3.4°C	ITS-90	(+) yellow (-) red	(+) brown (-) blue
R	-50 to 1768°C	1.9°C	4.0°C	ITS-90	no standard	(+) white (-) blue
S	-50 to 1768°C	1.9°C	4.0°C	ITS-90	no standard	(+) white (-) blue
B	100 to 300°C 300 to 1820°C	3.9°C 2.8°C	5.7°C 4.4°C	ITS-90	no standard	no standard
N	-200 to 1300°C -270 to -200°C	1.3°C **	3.1°C	ITS-90	(+) orange (-) red	(+) orange (-) blue
C (W5/W26)	0 to 2315°C	1.9°C	6.1°C	ASTM E988-90***	no standard	no standard

*After 20 min. warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 15 to 75% RH environment; and Accuracy over a 0 to 50°C and 0 to 85% RH (non condensing) environment. Accuracy specified over the 0 to 50°C operating range includes meter tempco and ice point tracking effects. The specification includes the A/D conversion errors, linearization conformity, and thermocouple ice point compensation. Total system accuracy is the sum of meter and probe errors. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

** The accuracy over the interval -270 to -200°C is a function of temperature, ranging from 1°C at -200°C and degrading to 7°C at -270°C. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

*** These curves have been corrected to ITS-90.

RTD INPUTS:
Type: 3 or 4 wire, 2 wire can be compensated for lead wire resistance
Excitation current: 100 ohm range: 165 μA
10 ohm range: 2.6 mA
Lead resistance: 100 ohm range: 10 ohm/lead max.
10 ohm range: 3 ohms/lead max.
Max. continuous overload: 30 V

INPUT TYPE	RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	STANDARD ***
100 ohm Pt alpha = .00385	-200 to 850°C	0.4°C	1.6°C	IEC 751
100 ohm Pt alpha = .003919	-200 to 850°C	0.4°C	1.6°C	no official standard
120 ohm Nickel alpha = .00672	-80 to 260°C	0.2°C	0.5°C	no official standard
10 ohm Copper alpha = .00427	-100 to 260°C	0.4°C	0.9°C	no official standard

CUSTOM RANGE: Up to 16 data point pairs
Input range: -10 to 65 mV
0 to 400 ohms, high range
0 to 25 ohms, low range
Display range: -19999 to 99999

INPUT TYPE	RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)
Custom mV range	-10 to 65mV (1 μV res.)	0.02% of reading + 4μV	0.12% of reading + 5μV
Custom 100 ohm range	0 to 400 Ω (10 MΩ res.)	0.02% of reading + 0.04 Ω	0.12% of reading + 0.05 Ω
Custom 10 ohm range	0 to 25 Ω (1 MΩ res.)	0.04% of reading + 0.005 Ω	0.20% of reading + 0.007 Ω

ACCESSORIES

UNITS LABEL KIT (PAXLBK) - Not required for PAXT

Each meter has a units indicator with backlighting that can be customized using the Units Label Kit. The backlight is controlled in the programming.

Each PAXT meter is shipped with °F and °C overlay labels which can be installed into the meter's bezel display assembly.

EXTERNAL CURRENT SHUNTS (APSCM)

To measure DC current signals greater than 2 ADC, a shunt must be used. The APSCM010 current shunt converts a maximum 10 ADC signal into 10.0 mV. The APSCM100 current shunt converts a maximum 100 ADC signal into 100.0 mV. The continuous current through the shunt is limited to 115% of the rating.

OPTIONAL PLUG-IN OUTPUT CARDS

WARNING: Disconnect all power to the unit before installing Plug-in cards.

Adding Option Cards

The PAX and MPAX series meters can be fitted with up to three optional plug-in cards. The details for each plug-in card can be reviewed in the specification section below. Only one card from each function type can be installed at one time. The function types include Setpoint Alarms (PAXCDS), Communications (PAXCDC), and Analog Output (PAXCDL). The plug-in cards can be installed initially or at a later date.

PAXH Isolation Specifications For All Option Cards

Isolation To Sensor Commons: 1400 Vrms for 1 min.
Working Voltage: 125 V
Isolation to User Input Commons: 500 Vrms for 1 min.
Working Voltage 50 V

COMMUNICATION CARDS (PAXCDC)

A variety of communication protocols are available for the PAX and MPAX series. Only one of these cards can be installed at a time. When programming the unit via RLCPro, a Windows® based program, the RS232 or RS485 Cards must be used.

PAXCDC10 - RS485 Serial
PAXCDC20 - RS232 Serial
PAXCDC30 - DeviceNet
PAXCDC40 - Modbus
PAXCDC50 - Profibus-DP

SERIAL COMMUNICATIONS CARD
Type: RS485 or RS232
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Data: 7/8 bits
Baud: 300 to 19,200
Parity: no, odd or even
Bus Address: Selectable 0 to 99, Max. 32 meters per line (RS485)
Transmit Delay: Selectable for 2 to 50 msec or 50 to 100 msec (RS485)

DEVICENET™ CARD
Compatibility: Group 2 Server Only, not UCMM capable
Baud Rates: 125 Kbaud, 250 Kbaud, and 500 Kbaud
Bus Interface: Phillips 82C250 or equivalent with MIS wiring protection per DeviceNet™ Volume I Section 10.2.2.
Node Isolation: Bus powered, isolated node
Host Isolation: 500 Vrms for 1 minute (50 V working) between DeviceNet™ and meter input common.

MODBUS CARD
Type: RS485; RTU and ASCII MODBUS modes
Isolation To Sensor & User Input Commons: 500 Vrms for 1 minute.
Working Voltage: 50 V. Not isolated from all other commons.
Baud Rates: 300 to 38400.
Data: 7/8 bits
Parity: No, Odd, or Even
Addresses: 1 to 247.
Transmit Delay: Programmable; See Transmit Delay explanation.

PROFIBUS-DP CARD
Fieldbus Type: Profibus-DP as per EN 50170, implemented with Siemens SPC3 ASIC
Conformance: PNO Certified Profibus-DP Slave Device
Baud Rates: Automatic baud rate detection in the range 9.6 Kbaud to 12 Mbaud
Station Address: 0 to 126, set by the master over the network. Address stored in non-volatile memory.
Connection: 9-pin Female D-Sub connector
Network Isolation: 500 Vrms for 1 minute (50 V working) between Profibus network and sensor and user input commons. Not isolated from all other commons.

PROGRAMMING SOFTWARE

Crimson is a Windows® based program that allows configuration of the PAX meter from a PC. Crimson offers standard drop-down menu commands, that make it easy to program the PAX meter. The PAX program can then be saved in a PC file for future use. A PAX serial plug-in card is required to program the meter using the software.

SETPOINT CARDS (PAXCDS)

The PAX and MPAX series has 4 available setpoint alarm output plug-in cards. Only one of these cards can be installed at a time. (Logic state of the outputs can be reversed in the programming.) These plug-in cards include:

PAXCDS10 - Dual Relay, FORM-C, Normally open & closed
PAXCDS20 - Quad Relay, FORM-A, Normally open only
PAXCDS30 - Isolated quad sinking NPN open collector
PAXCDS40 - Isolated quad sourcing PNP open collector

DUAL RELAY CARD
Type: Two FORM-C relays
Isolation To Sensor & User Input Commons: 2000 Vrms for 1 min.
Working Voltage: 240 Vrms
Contact Rating:
One Relay Energized: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @120 VAC, inductive load
Total current with both relays energized not to exceed 5 amps
Life Expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

QUAD RELAY CARD
Type: Four FORM-A relays
Isolation To Sensor & User Input Commons: 2300 Vrms for 1 min.
Working Voltage: 250 Vrms
Contact Rating:
One Relay Energized: 3 amps @ 240 VAC or 30 VDC (resistive load), 1/10 HP @120 VAC, inductive load
Total current with all four relays energized not to exceed 4 amps
Life Expectancy: 100K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

QUAD SINKING OPEN COLLECTOR CARD
Type: Four isolated sinking NPN transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Rating: 100 mA max @ V_{SAT} = 0.7 V max. V_{MAX} = 30 V

QUAD SOURCING OPEN COLLECTOR CARD
Type: Four isolated sourcing PNP transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Rating: Internal supply: 24 VDC ± 10% , 30 mA max. total
External supply: 30 VDC max., 100 mA max. each output

ALL FOUR SETPOINT CARDS
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

LINEAR DC OUTPUT (PAXCDL)

Either a 0(4)-20 mA or 0-10 V retransmitted linear DC output is available from the analog output plug-in card. The programmable output low and high scaling can be based on various display values. Reverse slope output is possible by reversing the scaling point positions.

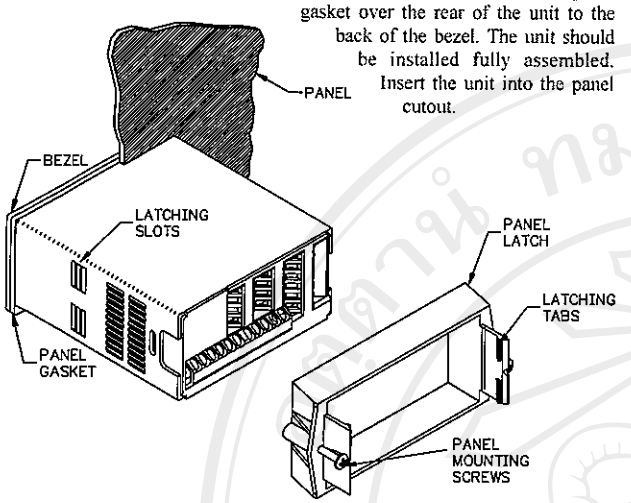
PAXCDL10 - Retransmitted Analog Output Card

ANALOG OUTPUT CARD
Types: 0 to 20 mA, 4 to 20 mA or 0 to 10 VDC
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Accuracy: 0.17% of FS (18 to 28°C); 0.4% of FS (0 to 50°C)
Resolution: 1/3500
Compliance: 10 VDC: 10 KΩ load min., 20 mA: 500 Ω load max.
Update time: 200 msec. max. to within 99% of final output value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

1.0 INSTALLING THE METER

Installation

The PAX meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.



While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch screws evenly until the unit is snug in the panel (Torque to approximately 7 in-lbs [79N-cm]). Do not over-tighten the screws.

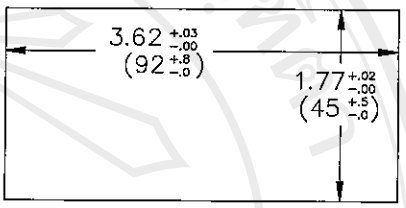
Installation Environment

The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.

PANEL CUT-OUT



2.0 SETTING THE JUMPERS

The meter can have up to four jumpers that must be checked and / or changed prior to applying power. The following Jumper Selection Figures show an enlargement of the jumper area.

To access the jumpers, remove the meter base from the case by firmly squeezing and pulling back on the side rear finger tabs. This should lower the latch below the case slot (which is located just in front of the finger tabs). It is recommended to release the latch on one side, then start the other side latch.

Input Range Jumper

This jumper is used to select the proper input range. The input range selected in programming must match the jumper setting. Select a range that is high enough to accommodate the maximum input to avoid overloads. The selection is different for each meter. See the Jumper Selection Figure for appropriate meter.

Excitation Output Jumper

If your meter has excitation, this jumper is used to select the excitation range for the application. If excitation is not being used, it is not necessary to check or move this jumper.

User Input Logic Jumper

This jumper selects the logic state of all the user inputs. If the user inputs are not used, it is not necessary to check or move this jumper.

PAXH:

Signal Jumper

This jumper is used to select the signal type. For current signals, the jumper is installed. For voltage signals, remove the jumper from the board. (For 2 V inputs, this removed jumper can be used in the "2 V only" location.)

Couple Jumper

This jumper is used for AC / DC couple. If AC couple, then the jumper is removed from the board. If DC couple is used, then the jumper is installed.

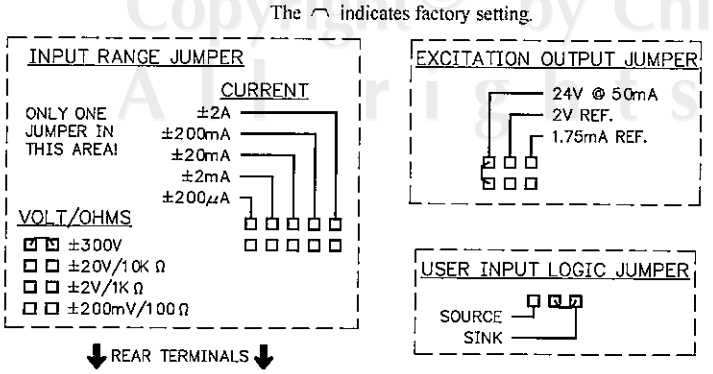
PAXD Jumper Selection

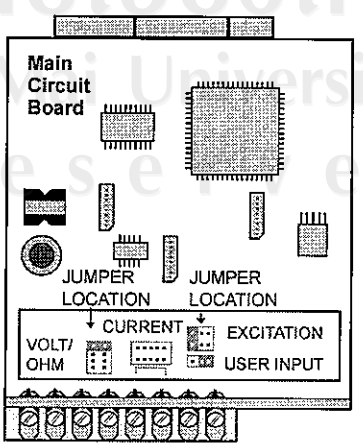
Input Range Jumper

One jumper is used for voltage/ohms or current input ranges. Select the proper input range high enough to avoid input signal overload. Only one jumper is allowed in this area. Do not have a jumper in both the voltage and current ranges at the same time. Avoid placing the jumper across two ranges.

JUMPER SELECTIONS

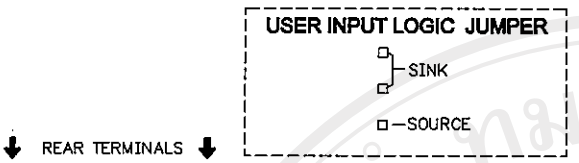
The ⌒ indicates factory setting.

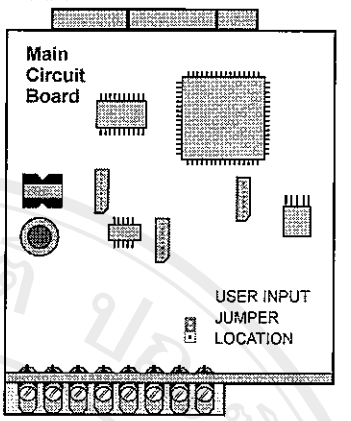




PAXP Jumper Selection

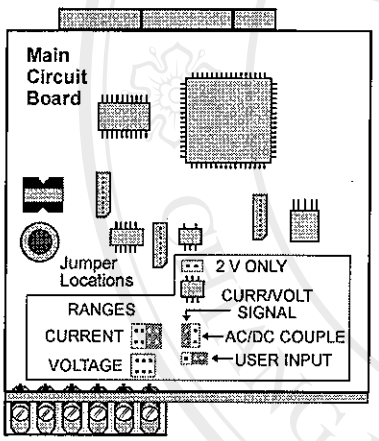
JUMPER SELECTIONS
The ⌒ indicates factory setting.



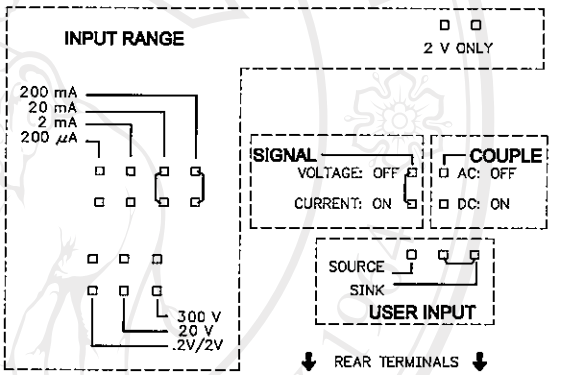


PAXH Jumper Selection

CAUTION: To maintain the electrical safety of the meter, remove unneeded jumpers completely from the meter. Do not move the jumpers to positions other than those specified.



JUMPER SELECTIONS
The ⌒ indicates factory setting.



Signal Jumper

One jumper is used for the input signal type. For current signals, the jumper is installed. For voltage signals, remove the jumper from the board. (For 2 V inputs, this removed jumper can be used in the "2 V only" location.)

Couple Jumper

One jumper is used for AC / DC couple. If AC couple is used, then the jumper is removed from the board. If DC couple is used, then the jumper is installed.

Input Range Jumper

For most inputs, one jumper is used to select the input range. However, for the following ranges, set the jumpers as stated:

5 A: Remove all jumpers from the input range.

2 V: Install one jumper in ".2/2V" position and one jumper in "2 V only".

All Other Ranges: One jumper in the selected range only.

Do not have a jumper in both the voltage and current ranges at the same time. Avoid placing a jumper across two ranges.

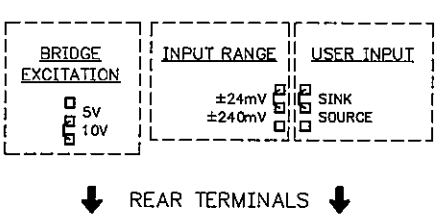
PAXS Jumper Selection

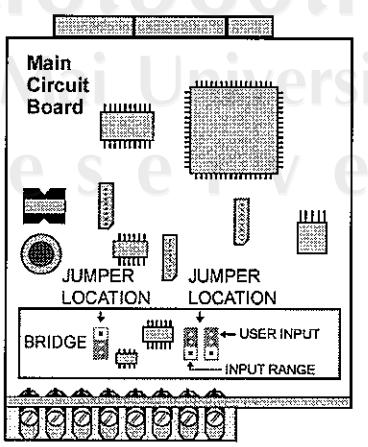
Bridge Excitation

One jumper is used to select bridge excitation to allow use of the higher sensitivity 24 mV input range. Use the 5 V excitation with high output (3 mV/V) bridges. The 5 V excitation also reduces bridge power compared to 10 V excitation.

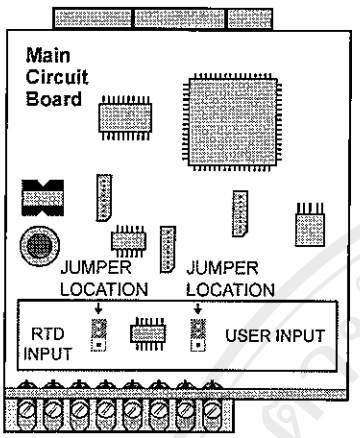
A maximum of four 350 ohm load cells can be driven by the internal bridge excitation voltage.

JUMPER SELECTIONS
The ⌒ indicates factory setting.





PAXT Jumper Selection

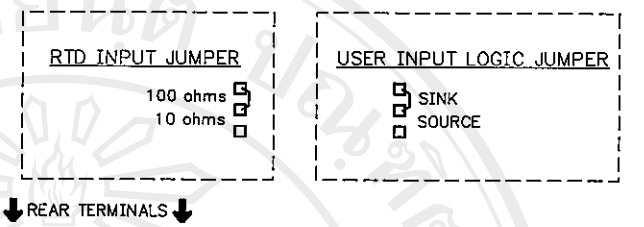


RTD Input Jumper

One jumper is used for RTD input ranges. Select the proper range to match the RTD probe being used. It is not necessary to remove this jumper when not using RTD probes.

JUMPER SELECTIONS

The ⌒ indicates factory setting.



3.0 WIRING THE METER

WIRING OVERVIEW

Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter's voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power supplied to the meter (DC or AC) be protected by a fuse or circuit breaker.

When wiring the meter, compare the numbers embossed on the back of the meter case against those shown in wiring drawings for proper wire position. Strip the wire, leaving approximately 0.3" (7.5 mm) bare lead exposed (stranded wires should be tinned with solder). Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.) Each terminal can accept up to one #14 AWG (2.55 mm) wire, two #18 AWG (1.02 mm), or four #20 AWG (0.61 mm).

EMC INSTALLATION GUIDELINES

Although this meter is designed with a high degree of immunity to Electro-Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, its source or the method of coupling into the unit may be different for various installations.Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The meter should be mounted in a metal enclosure, which is properly connected to protective earth.
2. With use of the lower input ranges or signal sources with high source impedance, the use of shielded cable may be necessary. This helps to guard against stray AC pick-up. Attach the shield to the input common of the meter. Line voltage monitoring and 5A CT applications do not usually require shielding.
3. To minimize potential noise problems, power the meter from the same power branch, or at least the same phase voltage as that of the signal source.
4. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
5. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.
6. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:

   Ferrite Suppression Cores for signal and control cables:
   Fair-Rite # 0443167251 (RLC #FCOR0000)
   TDK # ZCAT3035-1330A
   Steward #28B2029-0A0

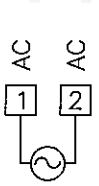
   Line Filters for input power cables:
   Schaffner # FN610-1/07 (RLC #LFIL0000)
   Schaffner # FN670-1.8/07
   Corcom #1VR3

   Note: Reference manufacturer's instructions when installing a line filter.
7. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
8. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.

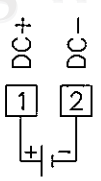
   Snubber: RLC#SNUB0000.

3.1 POWER WIRING

AC Power
Terminal 1: VAC
Terminal 2: VAC



DC Power
Terminal 1: +VDC
Terminal 2: -VDC

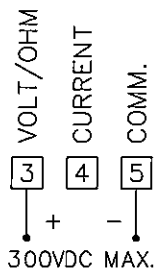


3.2 INPUT SIGNAL WIRING

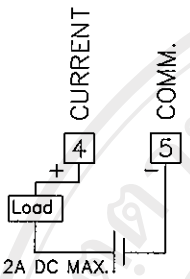
PAXD INPUT SIGNAL WIRING

Before connecting signal wires, the Input Range Jumper and Excitation Jumper should be verified for proper position.

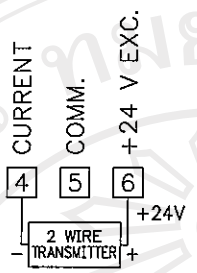
Voltage Signal (self powered)
Terminal 3: +VDC
Terminal 5: -VDC



Current Signal (self powered)
Terminal 4: +ADC
Terminal 5: -ADC

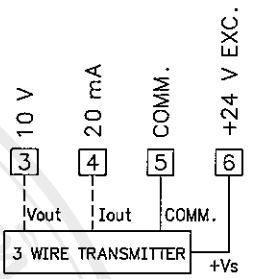


Current Signal (2 wire requiring excitation)
Terminal 4: -ADC
Terminal 6: +ADC
Excitation Jumper: 24 V

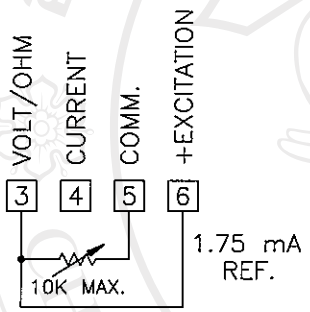


Current Signal (3 wire requiring excitation)
Terminal 4: +ADC (signal)
Terminal 5: -ADC (common)
Terminal 6: +Volt supply
Excitation Jumper: 24 V

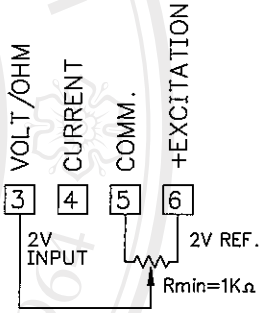
Voltage Signal (3 wire requiring excitation)
Terminal 3: +VDC (signal)
Terminal 5: -VDC (common)
Terminal 6: +Volt supply
Excitation Jumper: 24 V



Resistance Signal (3 wire requiring excitation)
Terminal 3: Resistance
Terminal 5: Resistance
Terminal 6: Jumper to terminal 3
Excitation Jumper: 1.75 mA REF.



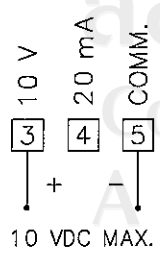
Potentiometer Signal (3 wire requiring excitation)
Terminal 3: Wiper
Terminal 5: Low end of pot.
Terminal 6: High end of pot.
Excitation Jumper: 2 V REF.
Input Range Jumper: 2 Volt
Module I Input Range: 2 Volt
Note: The Apply signal scaling style should be used because the signal will be in volts.



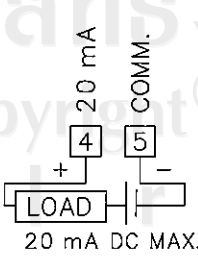
CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

PAXP INPUT SIGNAL WIRING

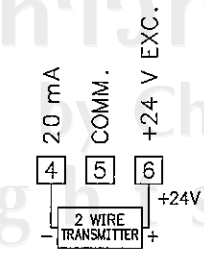
Voltage Signal (self powered)
Terminal 3: +VDC
Terminal 5: -VDC



Current Signal (self powered)
Terminal 4: +ADC
Terminal 5: -ADC

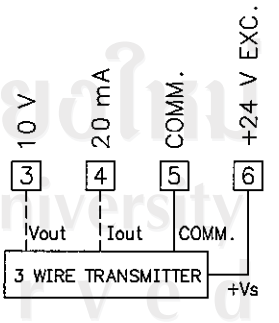


Current Signal (2 wire requiring excitation)
Terminal 4: -ADC
Terminal 6: +ADC



Current Signal (3 wire requiring excitation)
Terminal 4: +ADC (signal)
Terminal 5: -ADC (common)
Terminal 6: +Volt supply

Voltage Signal (3 wire requiring excitation)
Terminal 3: +VDC (signal)
Terminal 5: -VDC (common)
Terminal 6: +Volt supply

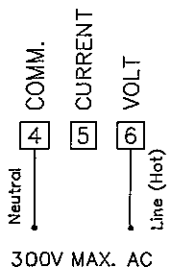


CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

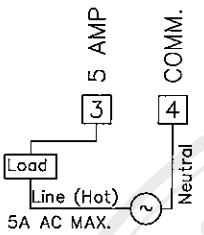
PAXH INPUT SIGNAL WIRING

Before connecting signal wires, the Signal, Input Range and Couple Jumpers should be verified for proper position.

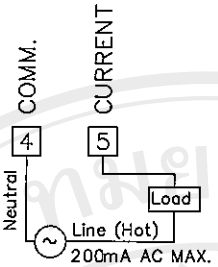
Voltage Signal



Current Signal (Amps)



Current Signal (Milliamps)



CAUTION: Connect only one input signal range to the meter. Hazardous signal levels may be present on unused inputs.

CAUTION: The isolation rating of the input common of the meter with respect to the option card commons and the user input common Terminal 8 (If used) is 125 Vrms; and 250 Vrms with respect to AC Power (meter Terminals 1 & 2). To be certain that the ratings are not exceeded, these voltages should be verified by a high-voltage meter before wiring the meter.

CAUTION:

1. Where possible, connect the neutral side of the signal (including current shunts) to the input common of the meter. If the input signal is sourced from an active circuit, connect the lower impedance (usually circuit common) to the input signal common of the meter.

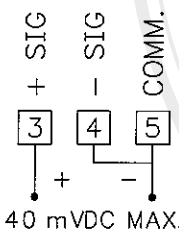
2. For phase-to-phase line monitoring where a neutral does not exist, or for any other signal input in which the isolation voltage rating is exceeded, an isolating potential transformer must be used to isolate the input voltage from earth. With the transformer, the input common of the meter can then be earth referenced for safety.

3. When measuring line currents, the use of a current transformer is recommended. If using external current shunts, insert the shunt in the neutral return line. If the isolation voltage rating is exceeded, the use of an isolating current transformer is necessary.

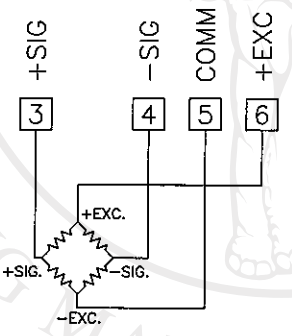
PAXS INPUT SIGNAL WIRING

Before connecting signal wires, the Input Range Jumper should be verified for proper position.

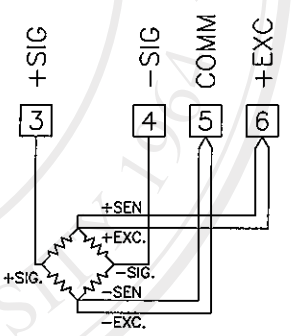
2-Wire Single Ended Input



4-Wire Bridge Input



6-Wire Bridge Input



DEADLOAD COMPENSATION

In some cases, the combined deadload and liveload output may exceed the range of the 24 mV input. To use this range, the output of the bridge can be offset a small amount by applying a fixed resistor across one arm of the bridge. This shifts the electrical output of the bridge downward to within the operating range of the meter. A 100 K ohm fixed resistor shifts the bridge output approximately -10 mV (350 ohm bridge, 10 V excitation).

Connect the resistor between +SIG and -SIG. Use a metal film resistor with a low temperature coefficient of resistance.

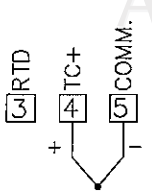
BRIDGE COMPLETION RESISTORS

For single strain gage applications, bridge completion resistors must be employed externally to the meter. Only use metal film resistors with a low temperature coefficient of resistance.

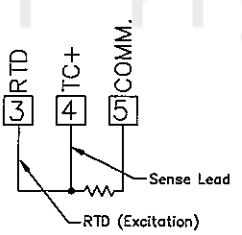
Load cells and pressure transducers are normally implemented as full resistance bridges and do not require bridge completion resistors.

PAXT INPUT SIGNAL WIRING

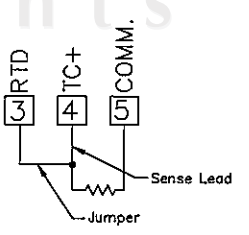
Thermocouple



3-Wire RTD



2-Wire RTD



CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

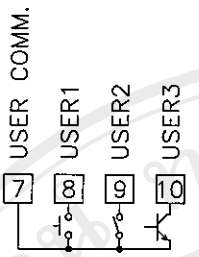
3.3 USER INPUT WIRING

Before connecting the wires, the User Input Logic Jumper should be verified for proper position. If not using User Inputs, then skip this section. Only the appropriate User Input terminal has to be wired.

Sinking Logic

Terminal 8-10: } Connect external switching device between
Terminal 7: } appropriate User Input terminal and User Comm.

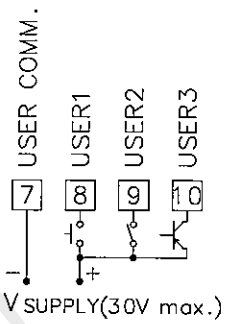
In this logic, the user inputs of the meter are internally pulled up to +5 V with 22 K resistance. The input is active when it is pulled low (<0 .9 V).



Sourcing Logic

Terminal 8-10: + VDC thru external switching device
Terminal 7: -VDC thru external switching device

In this logic, the user inputs of the meter are internally pulled down to 0 V with 22 K resistance. The input is active when a voltage greater than 3.6 VDC is applied.

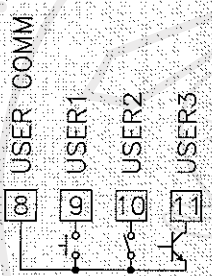


PAXH ONLY

Sinking Logic

Terminals 9-11 } Connect external
Terminal 8 } switching device between appropriate User Input terminal and User Comm.

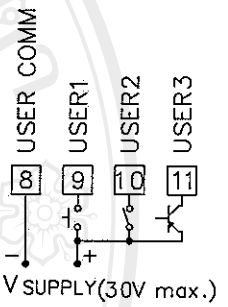
In this logic, the user inputs of the meter are internally pulled up to +5 V with 22 K resistance. The input is active when it is pulled low (<0 .9 V).



Sourcing Logic

Terminals 9-11:
+ VDC through external switching device
Terminal 8:
-VDC through external switching device

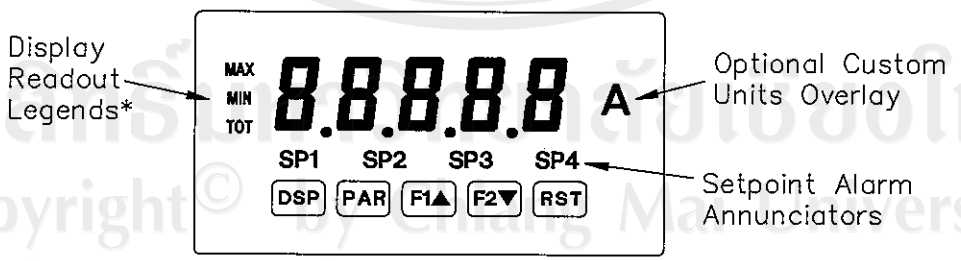
In this logic, the user inputs of the meter are internally pulled down with 22 K resistance. The input is active when a voltage greater than 3.6 VDC is applied.



3.4 SETPOINT (ALARMS) WIRING
3.5 SERIAL COMMUNICATION WIRING
3.6 ANALOG OUTPUT WIRING

} ***See appropriate plug-in card bulletin for details.***

4.0 REVIEWING THE FRONT BUTTONS AND DISPLAY



KEY	DISPLAY MODE OPERATION	PROGRAMMING MODE OPERATION
DSP	Index display through max/min/total/input readouts	Quit programming and return to display mode
PAR	Access parameter list	Store selected parameter and index to next parameter
F1▲	Function key 1; hold for 3 seconds for Second Function 1**	Increment selected parameter value
F2▼	Function key 2; hold for 3 seconds for Second Function 2**	Decrement selected parameter value
RST	Reset (Function key)**	Hold with F1▲, F2▼ to scroll value by x1000

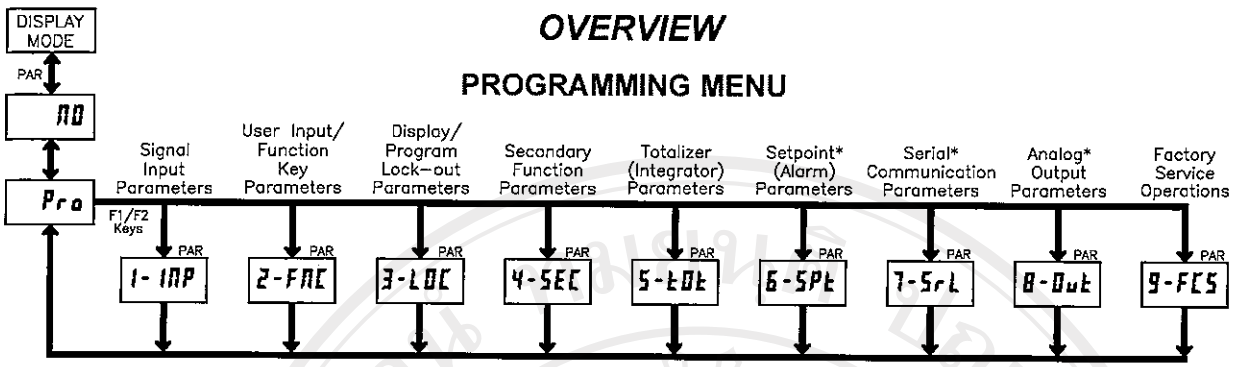
* Display Readout Legends may be locked out in Factory Settings.

** Factory setting for the F1, F2, and RST keys is NO mode.

5.0 PROGRAMMING THE METER

OVERVIEW

PROGRAMMING MENU



* Only accessible with appropriate plug-in card.

DISPLAY MODE

The meter normally operates in the Display Mode. In this mode, the meter displays can be viewed consecutively by pressing the **DSP** key. The annunciators to the left of the display indicate which display is currently shown; Max Value (MAX), Min Value (MIN), or Totalizer Value (TOT). Each of these displays can be locked from view through programming. (See Module 3) The Input Display Value is shown with no annunciator.

PROGRAMMING MODE

Two programming modes are available.

Full Programming Mode permits all parameters to be viewed and modified. Upon entering this mode, the front panel keys change to Programming Mode operations. This mode should not be entered while a process is running, since the meter functions and User Input response may not operate properly while in Full Programming Mode.

Quick Programming Mode permits only certain parameters to be viewed and/or modified. When entering this mode, the front panel keys change to Programming Mode operations, and all meter functions continue to operate properly. Quick Programming Mode is configured in Module 3. The Display Intensity Level "d-LEv" parameter is available in the Quick Programming Mode only when the security code is non-zero. For a description, see Module 9—Factory Service Operations. Throughout this document, Programming Mode (without Quick in front) always refers to "Full" Programming Mode.

PROGRAMMING TIPS

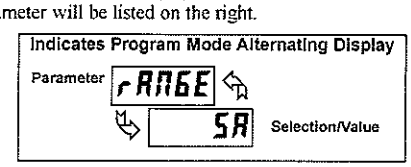
The Programming Menu is organized into nine modules (See above). These modules group together parameters that are related in function. It is recommended to begin programming with Module 1 and proceed through each module in sequence. Note that Modules 6 through 8 are only accessible when the appropriate plug-in option card is installed. If lost or confused while programming, press the **DSP** key to exit programming mode and start over. When programming is complete, it is recommended to record the meter settings on the Parameter Value Chart and lock-out parameter programming with a User Input or lock-out code. (See Modules 2 and 3 for lock-out details.)

FACTORY SETTINGS

Factory Settings may be completely restored in Module 9. This is a good starting point if encountering programming problems. Throughout the module description sections which follow, the factory setting for each parameter is shown below the parameter display. In addition, all factory settings are listed on the Parameter Value Chart following the programming section.

ALTERNATING SELECTION DISPLAY

In the module description sections which follow, the dual display with arrows appears for each programming parameter. This is used to illustrate the display alternating between the parameter (top display) and the parameter's Factory Setting (bottom display). In most cases, selections or value ranges for the parameter will be listed on the right.



STEP BY STEP PROGRAMMING INSTRUCTIONS:

PROGRAMMING MODE ENTRY (PAR KEY)

The Programming Mode is entered by pressing the **PAR** key. If this mode is not accessible, then meter programming is locked by either a security code or a hardware lock. (See Modules 2 and 3 for programming lock-out details.)

MODULE ENTRY (ARROW & PAR KEYS)

Upon entering the Programming Mode, the display alternates between Pro and the present module (initially no). The arrow keys (**F1▲** and **F2▼**) are used to select the desired module, which is then entered by pressing the **PAR** key.

PARAMETER (MODULE) MENU (PAR KEY)

Each module has a separate parameter menu. These menus are shown at the start of each module description section which follows. The **PAR** key is pressed to advance to a particular parameter to be changed, without changing the programming of preceding parameters. After completing a module, the display will return to Pro no. From this point, programming may continue by selecting and entering additional modules. (See **MODULE ENTRY** above.)

PARAMETER SELECTION ENTRY (ARROW & PAR KEYS)

For each parameter, the display alternates between the parameter and the present selection or value for that parameter. For parameters which have a list of selections, the arrow keys (**F1▲** and **F2▼**) are used to sequence through the list until the desired selection is displayed. Pressing the **PAR** key stores and activates the displayed selection, and also advances the meter to the next parameter.

NUMERICAL VALUE ENTRY (ARROW, RST & PAR KEYS)

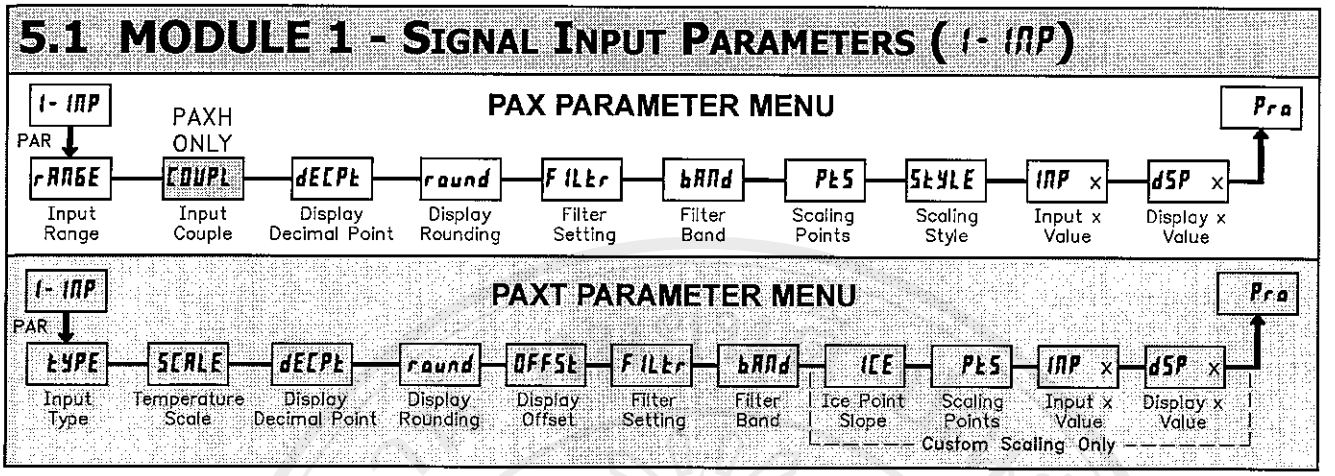
For parameters which require a numerical value entry, the arrow keys can be used to increment or decrement the display to the desired value. When an arrow key is pressed and held, the display automatically scrolls up or scrolls down. The longer the key is held, the faster the display scrolls.

The **RST** key can be used in combination with the arrow keys to enter large numerical values. When the **RST** key is pressed along with an arrow key, the display scrolls by 1000's. Pressing the **PAR** key stores and activates the displayed value, and also advances the meter to the next parameter.

PROGRAMMING MODE EXIT (DSP KEY or PAR KEY at Pro no)

The Programming Mode is exited by pressing the **DSP** key (from anywhere in the Programming Mode) or the **PAR** key (with Pro no displayed). This will commit any stored parameter changes to memory and return the meter to the Display Mode. If a parameter was just changed, the **PAR** key should be pressed to store the change before pressing the **DSP** key. (If power loss occurs before returning to the Display Mode, verify recent parameter changes.)

5.1 MODULE 1 - SIGNAL INPUT PARAMETERS (1- INP)



Refer to the appropriate Input Range for the selected meter. Use only one Input Range, then proceed to Display Decimal Point.

PAXD INPUT RANGE

rANGE
300u

SELECTION	RANGE RESOLUTION	SELECTION	RANGE RESOLUTION
200uA	±200.00 µA	2u	±2.0000 V
0.002A	±2.0000 mA	20u	±20.000 V
0.02A	±20.000 mA	300u	±300.00 V
0.2A	±200.00 mA	100o	100.00 ohm
2A	±2.0000 A	1000o	1000.0 ohm
0.2u	±200.00 mV	10Ko	10000 ohm

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXP INPUT RANGE

rANGE
0.02A

SELECTION	RANGE RESOLUTION
0.02A	20.000 mA
10u	10.000 V

Select the input range that corresponds to the external signal.

PAXH INPUT RANGE

rANGE
5A

SELECTION	RANGE RESOLUTION	SELECTION	RANGE RESOLUTION
0.2u	200.00 mV	0.002A	2.0000 mA
2u	2.0000 V	0.02A	20.000 mA
20u	20.000 V	0.2A	200.00 mA
300u	300.0 V	5A	5.000 A
200uA	200.00 µA		

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXH INPUT COUPLE

COUPL
AC

AC or dC

The input signal can be either AC coupled (rejecting the DC components of the signal) or DC coupled (measures both the AC and DC components of the signal). The coupling jumper and the setting of this parameter must match.

PAXS INPUT RANGE

rANGE
0.02u

SELECTION	RANGE RESOLUTION
0.02u	±24 mV
0.2u	±240 mV

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXT INPUT TYPE

tYPE
tc-J

SELECTION	TYPE	SELECTION	TYPE
tc-t	T TC	tc-c	C TC
tc-E	E TC	Pt385	RTD platinum 385
tc-J	J TC	Pt392	RTD platinum 392
tc-K	K TC	n.672	RTD nickel 672
tc-r	R TC	Cu427	RTD copper 10 Ω
tc-S	S TC	CS-tc	Custom TC
tc-b	B TC	CS-rH	Custom RTD High
tc-n	N TC	CS-rL	Custom RTD Low

Select the input type that corresponds to the input sensor. For RTD types, check the RTD Input Jumper for matching selection. For custom types, the Temperature Scale parameter is not available, the Display Decimal Point is expanded, and Custom Sensor Scaling must be completed.

PAXT TEMPERATURE SCALE

SCALE
oF

oF oC

Select the temperature scale. This selection applies for Input, MAX, MIN, and TOT displays. This does not change the user installed Custom Units Overlay display. If changed, those parameters that relate to the temperature scale should be checked. This selection is not available for custom sensor types.

DISPLAY DECIMAL POINT

dECPt
0

0 0.0 0.00 0.000 0.0000

For the PAXT, these are only available with Custom Scaling.

Select the decimal point location for the Input, **MAX** and **MIN** displays. (The **TOT** display decimal point is a separate parameter.) This selection also affects *round*, *dSP1* and *dSP2* parameters and setpoint values.

DISPLAY ROUNDING*

round → 1

1 2 5 10 20 50 100

These bottom selections are not available for the PAXT.

Rounding selections other than one, cause the Input Display to 'round' to the nearest rounding increment selected (ie. rounding of '5' causes 122 to round to 120 and 123 to round to 125). Rounding starts at the least significant digit of the Input Display. Remaining parameter entries (scaling point values, setpoint values, etc.) are not automatically adjusted to this display rounding selection.

PAXT: TEMPERATURE DISPLAY OFFSET*

OFFSE → 0 — -19999 to 99999

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors, errors due to variances in probe placement or adjusting the readout to a reference thermometer. This value is automatically updated after a Zero Display to show how far the display is offset. A value of zero will remove the affects of offset.

FILTER SETTING*

FILtr → 1.0 — 0.0 to 25.0 seconds

The input filter setting is a time constant expressed in tenths of a second. The filter settles to 99% of the final display value within approximately 3 time constants. This is an Adaptive Digital Filter which is designed to steady the Input Display reading. A value of '0' disables filtering.

FILTER BAND*

bAnd → 10 — 0.0 to 25.0 display units

The digital filter will adapt to variations in the input signal. When the variation exceeds the input filter band value, the digital filter disengages. When the variation becomes less than the band value, the filter engages again. This allows for a stable readout, but permits the display to settle rapidly after a large process change. The value of the band is in display units. A band setting of '0' keeps the digital filter permanently engaged.

For the PAXT, the following parameters only apply to Custom Sensor Scaling.

PAXT: ICE POINT SLOPE

ICE → 0.00 — 0 to 65.000 µV/°C

This parameter sets the slope value for ice point compensation for the Custom TC range (CS-tc) only. The fixed thermocouple ranges are automatically compensated by the meter and do not require this setting. To calculate this slope, use µV data obtained from thermocouple manufacturers' tables for two points between 0°C and 50°C. Place this corresponding µV and °C information into the equation:

slope = $(\mu V_2 - \mu V_1)/(°C_2 - °C_1)$.

Due to the nonlinear output of thermocouples, the compensation may show a small offset error at room temperatures. This can be compensated by the offset parameter. A value of 0 disables internal compensation when the thermocouple is externally compensated.

* *Factory Setting can be used without affecting basic start-up.*

SCALING POINTS*

PtS → 2 — 2 to 16

Linear - Scaling Points (2)

For linear processes, only 2 scaling points are necessary. It is recommended that the 2 scaling points be at opposite ends of the input signal being applied. The points do not have to be the signal limits. Display scaling will be linear between and continue past the entered points up to the limits of the Input Signal Jumper position. Each scaling point has a coordinate-pair of Input Value (*InP*) and an associated desired Display Value (*dSP*).

Nonlinear - Scaling Points (Greater than 2)

For non-linear processes, up to 16 scaling points may be used to provide a piece-wise linear approximation. (The greater the number of scaling points used, the greater the conformity accuracy.) The Input Display will be linear between scaling points that are sequential in program order. Each scaling point has a coordinate-pair of Input Value (*InP*) and an associated desired Display Value (*dSP*). Data from tables or equations, or empirical data could be used to derive the required number of segments and data values for the coordinate pairs. In the SFPAX software, several linearization equations are available.

SCALING STYLE

This parameter does not apply for the PAXT. Scaling values for the PAXT must be keyed-in.

StYLE → KEY — KEY key-in data; APLY apply signal

If Input Values and corresponding Display Values are known, the Key-in (*KEY*) scaling style can be used. This allows scaling without the presence or changing of the input signal. If Input Values have to be derived from the actual input signal source or simulator, the Apply (*APLY*) scaling style must be used. After using the Apply (*APLY*) scaling style, this parameter will default back to *KEY* but the scaling values will be shown from the previous applied method.

INPUT VALUE FOR SCALING POINT 1

InP 1 → 0.00 — -19999 to 99999

For Key-in (*KEY*), enter the known first Input Value by using the arrow keys. (The Input Range selection sets up the decimal location for the Input Value). For Apply (*APLY*), apply the input signal to the meter, adjust the signal source externally until the desired Input Value appears. In either method, press the **PAR** key to enter the value being displayed.

Note: APLY style - Pressing the **RST** *key will advance the display to the next scaling display point without storing the input value.*

DISPLAY VALUE FOR SCALING POINT 1

dSP 1 → 0.00 — -19999 to 99999

Enter the first coordinating Display Value by using the arrow keys. This is the same for *KEY* and *APLY* scaling styles. The decimal point follows the *dECPt* selection.

INPUT VALUE FOR SCALING POINT 2

InP 2 → 100.00 — -19999 to 99999

For Key-in (*KEY*), enter the known second Input Value by using the arrow keys. For Apply (*APLY*), adjust the signal source externally until the next desired Input Value appears. (Follow the same procedure if using more than 2 scaling points.)

DISPLAY VALUE FOR SCALING POINT 2

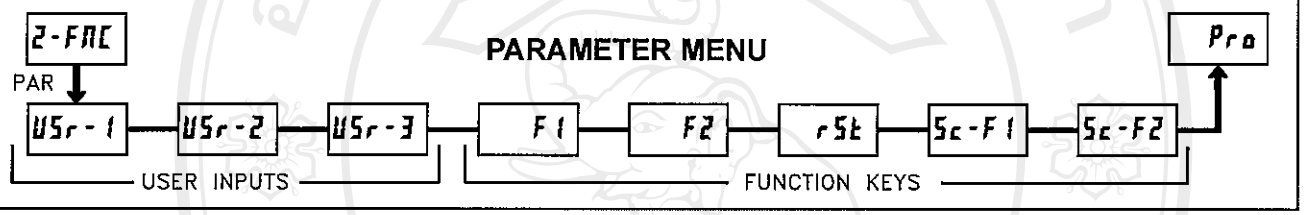
- 19999 to 99999

Enter the second coordinating Display Value by using the arrow keys. This is the same for KEY and APLY scaling styles. (Follow the same procedure if using more than 2 scaling points.)

General Notes on Scaling

1. Input Values for scaling points should be confined to the limits of the Input Range Jumper position.
2. The same Input Value should not correspond to more than one Display Value. (Example: 20 mA can not equal 0 and 10.)
   This is referred to as read out jumps (vertical scaled segments).
3. The same Display Value can correspond to more than one Input Value. (Example: 0 mA and 20 mA can equal 10.)
   This is referred to as readout dead zones (horizontal scaled segments).
4. The maximum scaled Display Value spread between range maximum and minimum is limited to 65,535. For example using +20 mA range the maximum +20 mA can be scaled to is 32,767 with 0 mA being 0 and Display Rounding of 1. (Decimal points are ignored.) The other half of 65,535 is for the lower half of the range 0 to -20 mA even if it is not used. With Display Rounding of 2, +20 mA can be scaled for 65,535 (32,767 x 2) but with even Input Display values shown.
5. For input levels beyond the first programmed Input Value, the meter extends the Display Value by calculating the slope from the first two coordinate pairs (INP 1 / dSP 1 & INP2 / dSP2). If INP 1 = 4 mA and dSP 1 = 0, then 0 mA would be some negative Display Value. This could be prevented by making INP 1 = 0 mA / dSP 1 = 0, INP2 = 4 mA / dSP2 = 0, with INP3 = 20 mA / dSP3 = the desired high Display Value. The calculations stop at the limits of the Input Range Jumper position.
6. For input levels beyond the last programmed Input Value, the meter extends the Display Value by calculating the slope from the last two sequential coordinate pairs. If three coordinate pair scaling points were entered, then the Display Value calculation would be between INP2 / dSP2 & INP3 / dSP3. The calculations stop at the limits of the Input Range Jumper position.

5.2 MODULE 2 - USER INPUT AND FRONT PANEL FUNCTION KEY PARAMETERS (2-FNC)



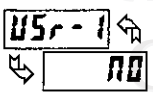
The three user inputs are individually programmable to perform specific meter control functions. While in the Display Mode or Program Mode, the function is executed the instant the user input transitions to the active state.

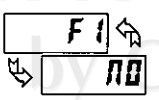
The front panel function keys are also individually programmable to perform specific meter control functions. While in the Display Mode, the primary function is executed the instant the key is pressed. Holding the function key for three seconds executes a secondary function. It is possible to program a secondary function without a primary function.

In most cases, if more than one user input and/or function key is programmed for the same function, the maintained (level trigger) actions will be performed while at least one of those user inputs or function keys are activated. The momentary (edge trigger) actions will be performed every time any of those user inputs or function keys transition to the active state.

Note: In the following explanations, not all selections are available for both user inputs and front panel function keys. Alternating displays are shown with each selection. Those selections showing both displays are available for both. If a display is not shown, it is not available for that selection. USr-1 *will represent all three user inputs.* F1 *will represent all five function keys.*

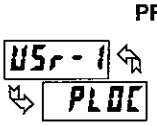
NO FUNCTION





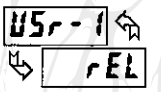
No function is performed if activated. This is the factory setting for all user inputs and function keys. No function can be selected without affecting basic start-up.

PROGRAMMING MODE LOCK-OUT



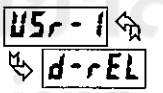
Programming Mode is locked-out, as long as activated (maintained action). A security code can be configured to allow programming access during lock-out.

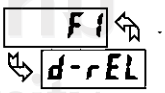
ZERO (TARE) DISPLAY



The Zero (Tare) Display provides a way to zero the Input Display value at various input levels, causing future Display readings to be offset. This function is useful in weighing applications where the container or material on the scale should not be included in the next measurement value. When activated (momentary action), rESEt flashes and the Display is set to zero. At the same time, the Display value (that was on the display before the Zero Display) is subtracted from the Display Offset Value and is automatically stored as the new Display Offset Value (OFFSt). If another Zero (tare) Display is performed, the display will again change to zero and the Display reading will shift accordingly.

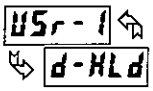
RELATIVE/ABSOLUTE DISPLAY





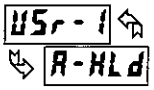
This function will switch the Input Display between Relative and Absolute. The Relative is a net value that includes the Display Offset Value. The Input Display will normally show the Relative unless switched by this function. Regardless of the display selected, all meter functions continue to operate based on relative values. The Absolute is a gross value (based on Module 1 **DSP** and **INP** entries) without the Display Offset Value. The Absolute display is selected as long as the user input is activated (maintained action) or at the transition of the function key (momentary action). When the user input is released, or the function key is pressed again, the input display switches back to Relative display. AbS (absolute) or rEL (relative) is momentarily displayed at transition to indicate which display is active.

HOLD DISPLAY



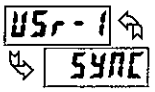
The shown display is held but all other meter functions continue as long as activated (maintained action).

HOLD ALL FUNCTIONS



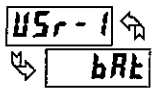
The meter disables processing the input, holds all display contents, and locks the state of all outputs as long as activated (maintained action). The serial port continues data transfer.

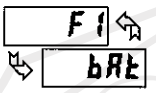
SYNCHRONIZE METER READING



The meter suspends all functions as long as activated (maintained action). When the user input is released, the meter synchronizes the restart of the A/D with other processes or timing events.

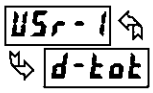
STORE BATCH READING IN TOTALIZER





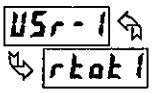
The Input Display value is one time added (batched) to the Totalizer at transition to activate (momentary action). The Totalizer retains a running sum of each batch operation until the Totalizer is reset. When this function is selected, the normal operation of the Totalizer is overridden.

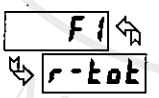
SELECT TOTALIZER DISPLAY



The Totalizer display is selected as long as activated (maintained action). When the user input is released, the Input Display is returned. The **DSP** key overrides the active user input. The Totalizer continues to function including associated outputs independent of being displayed.

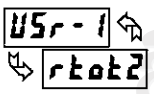
RESET TOTALIZER





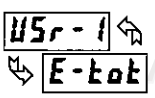
When activated (momentary action), rESEt flashes and the Totalizer resets to zero. The Totalizer then continues to operate as it is configured. This selection functions independent of the selected display.

RESET AND ENABLE TOTALIZER



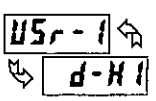
When activated (momentary action), rESEt flashes and the Totalizer resets to zero. The Totalizer continues to operate while active (maintained action). When the user input is released, the Totalizer stops and holds its value. This selection functions independent of the selected display.

ENABLE TOTALIZER



The Totalizer continues to operate as long as activated (maintained action). When the user input is released, the Totalizer stops and holds its value. This selection functions independent of the selected display.

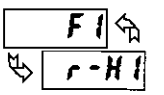
SELECT MAXIMUM DISPLAY



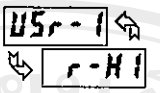
The Maximum display is selected as long as activated (maintained action). When the user input is released, the Input Display returns. The **DSP** key overrides the active user input. The Maximum continues to function independent of being displayed.

RESET MAXIMUM

When activated (momentary action), rESEt flashes and the Maximum resets to the present Input Display value. The Maximum function then continues from that value. This selection functions independent of the selected display.

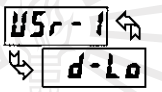


RESET, SELECT, ENABLE MAXIMUM DISPLAY



When activated (momentary action), the Maximum value is set to the present Input Display value. Maximum continues from that value while active (maintained action). When the user input is released, Maximum detection stops and holds its value. This selection functions independent of the selected display. The **DSP** key overrides the active user input display but not the Maximum function.

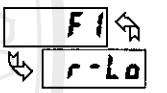
SELECT MINIMUM DISPLAY



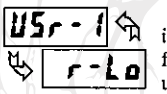
The Minimum display is selected as long as activated (maintained action). When the user input is released, the Input Display is returned. The **DSP** key overrides the active user input. The Minimum continues to function independent of being displayed.

RESET MINIMUM

When activated (momentary action), rESEt flashes and the Minimum reading is set to the present Input Display value. The Minimum function then continues from that value. This selection functions independent of the selected display.

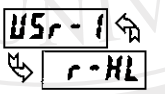


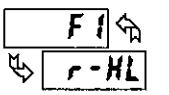
RESET, SELECT, ENABLE MINIMUM DISPLAY



When activated (momentary action), the Minimum value is set to the present Input Display value. Minimum continues from that value while active (maintained action). When the user input is released, Minimum detection stops and holds its value. This selection functions independent of the selected display. The **DSP** key overrides the active user input display but not the Minimum function.

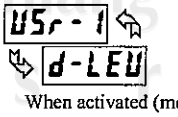
RESET MAXIMUM AND MINIMUM

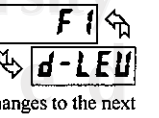




When activated (momentary action), rESEt flashes and the Maximum and Minimum readings are set to the present Input Display value. The Maximum and Minimum function then continues from that value. This selection functions independent of the selected display.

CHANGE DISPLAY INTENSITY LEVEL





When activated (momentary action), the display intensity changes to the next intensity level (of 4). The four levels correspond to Display Intensity Level (d-LEu) settings of 0, 3, 8, and 15. The intensity level, when changed via the User Input/ Function Key, is not retained at power-down, unless Quick Programming or Full Programming mode is entered and exited. The meter will power-up at the last saved intensity level.

SETPOINT SELECTIONS

The following selections are accessible only with the Setpoint plug-in card installed. Refer to the Setpoint Card Bulletin shipped with the Setpoint plug-in card for an explanation of their operation.

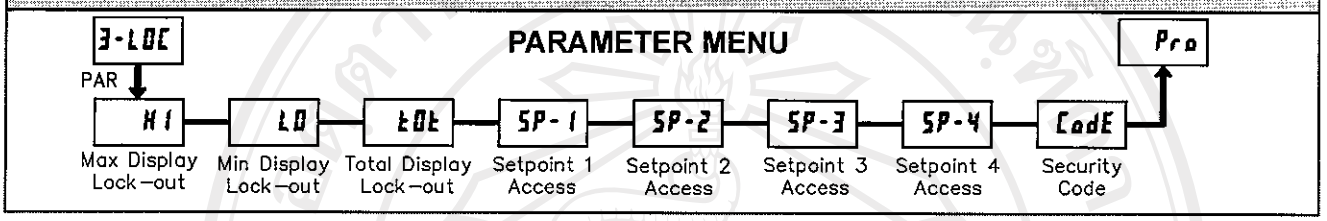
Setpoint Card Only

- **LISt - Select main or alternate setpoints**
- **r-1 - Reset Setpoint 1 (Alarm 1)**
- **r-2 - Reset Setpoint 2 (Alarm 2)**
- **r-3 - Reset Setpoint 3 (Alarm 3)**
- **r-4 - Reset Setpoint 4 (Alarm 4)**
- **r-34 - Reset Setpoint 3 & 4 (Alarm 3 & 4)**
- **r-234 - Reset Setpoint 2, 3 & 4 (Alarm 2, 3 & 4)**
- **r-ALL - Reset Setpoint All (Alarm All)**

PRINT REQUEST

The meter issues a block print through the serial port when activated. The data transmitted during a print request is programmed in Module 7. If the user input is still active after the transmission is complete (about 100 msec), an additional transmission occurs. As long as the user input is held active, continuous transmissions occur.

5.3 MODULE 3 - DISPLAY AND PROGRAM LOCK-OUT PARAMETERS (3-LOC)



Module 3 is the programming for Display lock-out and "Full" and "Quick" Program lock-out.

When in the Display Mode, the available displays can be read consecutively by repeatedly pressing the **DSP** key. An annunciator indicates the display being shown. These displays can be locked from being visible. It is recommended that the display be set to LOC when the corresponding function is not used.

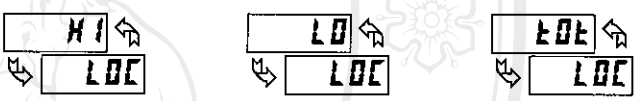
SELECTION	DESCRIPTION
rEd	Visible in Display Mode
LOC	Not visible in Display Mode

"Full" Programming Mode permits all parameters to be viewed and modified. This Programming Mode can be locked with a security code and/or user input. When locked and the **PAR** key is pressed, the meter enters a Quick Programming Mode. In this mode, the setpoint values can still be read and/or changed per the selections below. The Display Intensity Level (d-LEU) parameter also appears whenever Quick Programming Mode is enabled and the security code is greater than zero.

SELECTION	DESCRIPTION
rEd	Visible but not changeable in Quick Programming Mode
EntE	Visible and changeable in Quick Programming Mode
LOC	Not visible in Quick Programming Mode

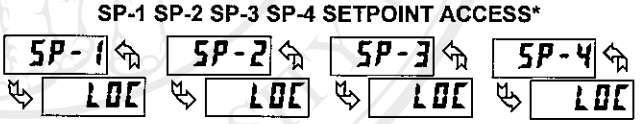
* *Factory Setting can be used without affecting basic start-up.*

MAXIMUM DISPLAY LOCK-OUT*
MINIMUM DISPLAY LOCK-OUT*
TOTALIZER DISPLAY LOCK-OUT*



These displays can be programmed for LOC or rEd. When programmed for LOC, the display will not be shown when the **DSP** key is pressed regardless of Program Lock-out status. It is suggested to lock-out the display if it is not needed. The associated function will continue to operate even if its display is locked-out.

SP-1 SP-2 SP-3 SP-4 SETPOINT ACCESS*



The setpoint displays can be programmed for LOC, rEd or EntE (See the following table). Accessible only with the Setpoint plug-in card installed.

PROGRAM MODE SECURITY CODE*

By entering any non-zero value, the prompt CodE 0 will appear when trying to access the Program Mode. Access will only be allowed after entering a matching security code or universal code of 222. With this lock-out, a user input would not have to be configured for Program Lock-out. However, this lock-out is overridden by an inactive user input configured for Program Lock-out.

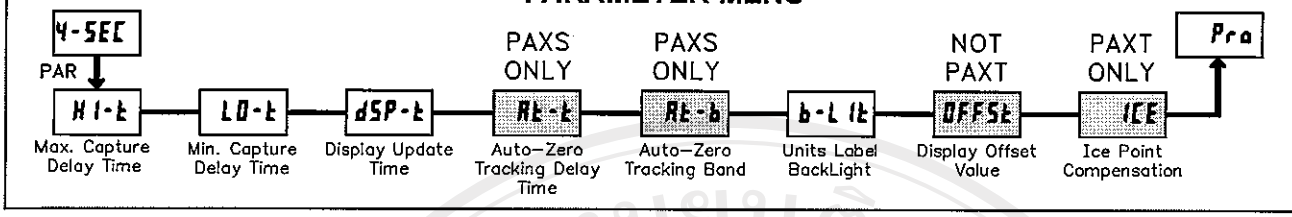
PROGRAMMING MODE ACCESS

SECURITY CODE	USER INPUT CONFIGURED	USER INPUT STATE	WHEN PAR KEY IS PRESSED	"FULL" PROGRAMMING MODE ACCESS
0	not PLOC	———	"Full" Programming	Immediate access.
>0	not PLOC	———	Quick Programming w/Display Intensity	After Quick Programming with correct code # at CodE prompt.
>0	PLOC	Active	Quick Programming w/Display Intensity	After Quick Programming with correct code # at CodE prompt.
>0	PLOC	Not Active	"Full" Programming	Immediate access.
0	PLOC	Active	Quick Programming	No access
0	PLOC	Not Active	"Full" Programming	Immediate access.

Throughout this document, Programming Mode (without Quick in front) always refers to "Full" Programming (all meter parameters are accessible).

5.4 MODULE 4 - SECONDARY FUNCTION PARAMETERS (4-SEC)

PARAMETER MENU



MAX CAPTURE DELAY TIME*

H1-t
0.0

0.0 to 3275.0 sec.

When the Input Display is above the present MAX value for the entered delay time, the meter will capture that display value as the new MAX reading. A delay time helps to avoid false captures of sudden short spikes.

MIN CAPTURE DELAY TIME*

LO-t
0.0

0.0 to 3275.0 sec.

When the Input Display is below the present MIN value for the entered delay time, the meter will capture that display value as the new MIN reading. A delay time helps to avoid false captures of sudden short spikes.

DISPLAY UPDATE RATE*

dSP-t
2

1 2 5 10 20 updates/sec.

This parameter determines the rate of display update. When set to 20 updates/second, the internal re-zero compensation is disabled, allowing for the fastest possible output response.

PAXS: AUTO-ZERO TRACKING

Rt-t
0

0 to 250 sec.

PAXS: AUTO-ZERO BAND

Rt-b
0.02

1 to 4095

The meter can be programmed to automatically compensate for zero drift. Drift may be caused by changes in the transducers or electronics, or accumulation of material on weight systems.

Auto-zero tracking operates when the readout remains within the tracking band for a period of time equal to the tracking delay time. When these conditions are met, the meter re-zeroes the readout. After the re-zero operation, the meter resets and continues to auto-zero track.

The auto-zero tracking band should be set large enough to track normal zero drift, but small enough to not interfere with small process inputs.

For filling operations, the fill rate must exceed the auto-zero tracking rate. This avoids false tracking at the start of the filling operation.

$$\text{Fill Rate} \geq \frac{\text{tracking band}}{\text{tracking time}}$$

Auto-zero tracking is disabled by setting the auto-zero tracking parameter = 0.

UNITS LABEL BACKLIGHT*

b-L It
OFF

ON OFF

The Units Label Kit Accessory contains a sheet of custom unit overlays which can be installed in to the meter's bezel display assembly. The backlight for these custom units is activated by this parameter.

DISPLAY OFFSET VALUE*

This parameter does not apply for the PAXT.

OFFSt
0.00

-19999 to 19999

Unless a Zero Display was performed or an offset from Module 1 scaling is desired, this parameter can be skipped. The Display Offset Value is the difference from the Absolute (gross) Display value to the Relative (net) Display value for the same input level. The meter will automatically update this Display Offset Value after each Zero Display. The Display Offset Value can be directly keyed-in to intentionally add or remove display offset. See Relative / Absolute Display and Zero Display explanations in Module 2.

PAXT: ICE POINT COMPENSATION*

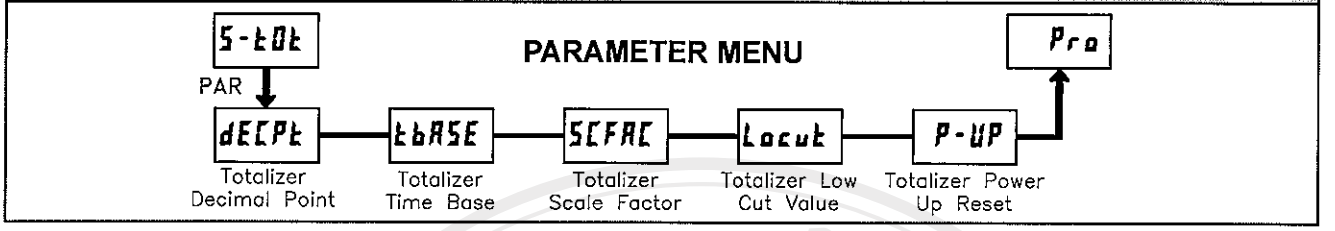
ICE
ON

ON OFF

This parameter turns the internal ice point compensation on or off. Normally, the ice point compensation is on. If using external compensation, set this parameter to off. In this case, use copper leads from the external compensation point to the meter. If using Custom TC range, the ice point compensation can be adjusted by a value in Module 1 when this is yes.

* *Factory Setting can be used without affecting basic start-up.*

5.5 MODULE 5 - TOTALIZER (INTEGRATOR) PARAMETERS (5-tOt)



The totalizer accumulates (integrates) the Input Display value using one of two modes. The first is using a time base. This can be used to compute a time-temperature product. The second is through a user input or function key programmed for Batch (one time add on demand). This can be used to provide a readout of temperature integration, useful in curing and sterilization applications. If the Totalizer is not needed, its display can be locked-out and this module can be skipped during programming.

TOTALIZER DECIMAL POINT*

dECPt → 0.00

0 0.0 0.00 0.000 0.0000

For most applications, this matches the Input Display Decimal Point (*dECPt*). If a different location is desired, refer to Totalizer Scale Factor.

TOTALIZER TIME BASE

tbASE → .1M

SEC - seconds (÷ 1) hour - hours (÷ 3600)
.1M - minutes (÷ 60) dAY - days (÷ 86400)

This is the time base used in Totalizer accumulations. If the Totalizer is being accumulated through a user input programmed for Batch, then this parameter does not apply.

TOTALIZER SCALE FACTOR*

SCFAC → 1.000

0.001 to 65.000

For most applications, the Totalizer reflects the same decimal point location and engineering units as the Input Display. In these cases, the Totalizer Scale Factor is 1.000. The Totalizer Scale Factor can be used to scale the Totalizer to a different value than the Input Display. Common possibilities are:

1. Changing decimal point location (example tenths to whole)
2. Average over a controlled time frame.

Details on calculating the scale factor are shown later.

If the Totalizer is being accumulated through a user input programmed for Batch, then this parameter does not apply.

TOTALIZER LOW CUT VALUE*

Locut → -19999

-19999 to 99999

A low cut value disables Totalizer when the Input Display value falls below the value programmed.

TOTALIZER POWER UP RESET*

P-UP → nO

nO Do not reset buffer
rSt Reset buffer

The Totalizer can be reset to zero on each meter power-up by setting this parameter to reset.

* *Factory Setting can be used without affecting basic start-up.*

TOTALIZER HIGH ORDER DISPLAY

When the total exceeds 5 digits, the front panel annunciator **TOT** flashes. In this case, the meter continues to totalize up to a 9 digit value. The high order 4 digits and the low order 5 digits of the total are displayed alternately. The letter "h" denotes the high order display.

TOTALIZER BATCHING

The Totalizer Time Base and scale factor are overridden when a user input or function key is programmed for store batch (*bAt*). In this mode, when the user input or function key is activated, the Input Display reading is one time added to the Totalizer (batch). The Totalizer retains a running sum of each batch operation until the Totalizer is reset. This is useful in weighing operations, when the value to be added is not based on time but after a filling event.

TOTALIZER USING TIME BASE

Totalizer accumulates as defined by:

$$\frac{\text{Input Display} \times \text{Totalizer Scale Factor}}{\text{Totalizer Time Base}}$$

Where:
Input Display - the present input reading
Totalizer Scale Factor - 0.001 to 65.000
Totalizer Time Base - (the division factor of *tbASE*)

Example: The input reading is at a constant rate of 10.0 gallons per minute. The Totalizer is used to determine how many gallons in tenths has flowed. Because the Input Display and Totalizer are both in tenths of gallons, the Totalizer Scale Factor is 1. With gallons per minute, the Totalizer Time Base is minutes (60). By placing these values in the equation, the Totalizer will accumulate every second as follows:

$\frac{10.0 \times 1.000}{60} = 0.1667$ gallon accumulates each second

This results in:
10.0 gallons accumulates each minute
600.0 gallons accumulates each hour

TOTALIZER SCALE FACTOR CALCULATION EXAMPLES

1. When changing the Totalizer Decimal Point (*dECPt*) location from the Input Display Decimal Point (*dECPt*), the required Totalizer Scale Factor is multiplied by a power of ten.

Example: Input (*dECPt*) = 0.0 Input (*dECPt*) = 0.00

Totalizer *dECPt*	Scale Factor
0.00	10
0.0	1
0	.1
x10	.01
x100	.001

Totalizer *dECPt*	Scale Factor
0.000	10
0.00	1
0.0	.1
0	.01
x10	.001

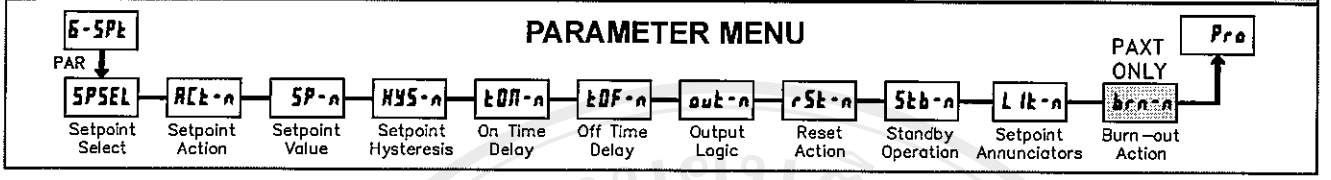
(x = Totalizer display is round by tens or hundreds)

2. To obtain an average reading within a controlled time frame, the selected Totalizer Time Base is divided by the given time period expressed in the same timing units.

Example: Average temperature per hour in a 4 hour period, the scale factor would be 0.250. To achieve a controlled time frame, connect an external timer to a user input programmed for *rtbtE*. The timer will control the start (reset) and the stopping (hold) of the totalizer.

Modules 6, 7, and 8 are accessible only with the appropriate plug-in cards installed. A quick overview of each Module is listed below. Refer to the corresponding plug-in card bulletin for a more detailed explanation of each parameter selection.

5.6 MODULE 6 - SETPOINT (ALARM) PARAMETERS (6-SPt)

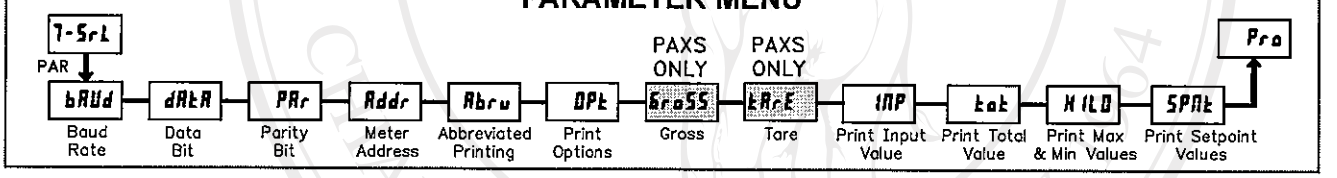


Repeat programming for each setpoint.

SPSEL - SELECT SETPOINT	no	SP-1 SP-3 SP-2 SP-4
ACt-n - SETPOINT ACTION		OFF dE-HI Ab-HI dE-LO Ab-LO bAnd AU-HI toLo AU-LO toHI
SP-n - SETPOINT VALUE		-19999 to 99999
HYS-n - SETPOINT HYSTERESIS		1 to 65000

tON-n - ON TIME DELAY	0.0 to 3275.0 sec	
tOF-n - OFF TIME DELAY	0.0 to 3275.0 sec	
out-n - OUTPUT LOGIC	nor	rEu
rSt-n - RESET ACTION	AUto LAtC2 LAtC1	
Stb-n - STANDBY OPERATION	no	YES
L It-n - SETPOINT ANNUNCIATORS	OFF nor	rEu FLASH
brn-n - PROBE BURN-OUT ACTION PAXT ONLY	on	OFF

5.7 MODULE 7 - SERIAL COMMUNICATIONS PARAMETERS (7-SrL)



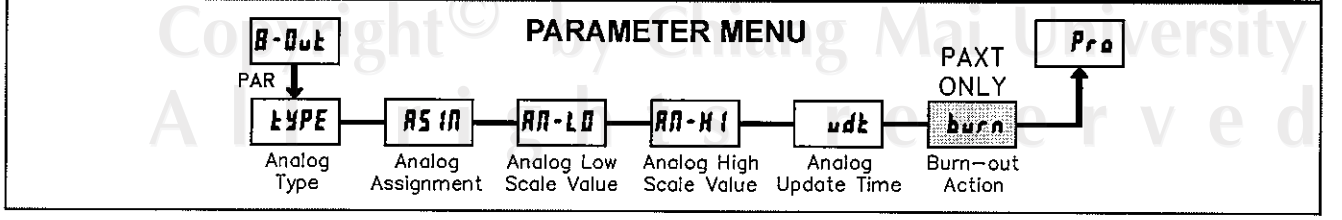
This module is for RS232 and RS485.

bAUd - BAUD RATE	300 600 1200 2400	4800 9600 19200
dAtA - DATA BITS	7	8
PAr - PARITY BIT	Odd EVEN	no

Addr - METER ADDRESS	0 to 99	
Abru - ABBREVIATED PRINTING	no	YES
OPt - PRINT OPTIONS	no	
	YES GroSS	tArE
	inP	H iLO
	tot	SPnt

These two options are for the PAXS ONLY.

5.8 MODULE 8 - ANALOG OUTPUT PARAMETERS (8-Out)



tYPE - ANALOG TYPE	0-20 4-20	0-10
AS in - ANALOG ASSIGNMENT	inP HI	LO tot

An-LO - ANALOG LOW SCALE VALUE	-19999 to 99999
An-HI - ANALOG HIGH SCALE VALUE	-19999 to 99999
udt - ANALOG UPDATE TIME	0.0 to 10.0 sec.
burn - PROBE BURN-OUT ACTION PAXT ONLY	HI LO

red lion
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion.net

Bulletin No. PAX-G
Drawing No. LP0545
Released 8/07

MODEL PAX – 1/8 DIN ANALOG INPUT PANEL METERS

- *PROCESS, VOLTAGE, CURRENT, TEMPERATURE, AND STRAIN GAGE INPUTS*
- *5-DIGIT 0.56" RED SUNLIGHT READABLE DISPLAY*
- *VARIABLE INTENSITY DISPLAY*
- *16 POINT SCALING FOR NON-LINEAR PROCESSES*
- *PROGRAMMABLE FUNCTION KEYS/USER INPUTS*
- *9 DIGIT TOTALIZER (INTEGRATOR) WITH BATCHING*
- *OPTIONAL CUSTOM UNITS OVERLAY W/BACKLIGHT*
- *FOUR SETPOINT ALARM OUTPUTS (W/OPTION CARD)*
- *COMMUNICATION AND BUS CAPABILITIES (W/OPTION CARD)*
- *RETRANSMITTED ANALOG OUTPUT (W/OPTION CARD)*
- *CRIMSON PROGRAMMING SOFTWARE*
- *NEMA 4X/IP65 SEALED FRONT BEZEL*

C

GENERAL DESCRIPTION

The PAX Analog Panel Meters offer many features and performance capabilities to suit a wide range of industrial applications. Available in five different models to handle various analog inputs, including DC Voltage/Current, AC Voltage/Current, Process, Temperature, and Strain Gage Inputs. Refer to pages 4 through 6 for the details on the specific models. The optional plug-in output cards allow the opportunity to configure the meter for present applications, while providing easy upgrades for future needs.

The meters employ a bright 0.56" LED display. The unit is available with a red sunlight readable or a standard green LED. The intensity of display can be adjusted from dark room applications up to sunlight readable, making it ideal for viewing in bright light applications.

The meters provide a MAX and MIN reading memory with programmable capture time. The capture time is used to prevent detection of false max or min readings which may occur during start-up or unusual process events.

The signal totalizer (integrator) can be used to compute a time-input product. This can be used to provide a readout of totalized flow, calculate service intervals of motors or pumps, etc. The totalizer can also accumulate batch weighing operations.

The meters have four setpoint outputs, implemented on Plug-in option cards. The Plug-in cards provide dual FORM-C relays (5A), quad FORM-A (3A), or either quad sinking or quad sourcing open collector logic outputs. The setpoint alarms can be configured to suit a variety of control and alarm requirements.

Communication and Bus Capabilities are also available as option cards. These include RS232, RS485, Modbus, DeviceNet, and Profibus-DP. Readout values and setpoint alarm values can be controlled through the bus. Additionally, the meters have a feature that allows a remote computer to directly control the outputs of the meter. With an RS232 or RS485 card installed, it is possible to configure the meter using a Windows® based program. The configuration data can be saved to a file for later recall.

A linear DC output signal is available as an optional Plug-in card. The card provides either 20 mA or 10 V signals. The output can be scaled independent of the input range and can track either the input, totalizer, max or min readings.

Once the meters have been initially configured, the parameter list may be locked out from further modification in its entirety or only the setpoint values can be made accessible.

The meters have been specifically designed for harsh industrial environments. With NEMA 4X/IP65 sealed bezel and extensive testing of noise effects to CE requirements, the meter provides a tough yet reliable application solution.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in this literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

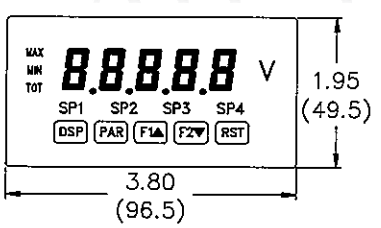
Do not use this unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the unit.

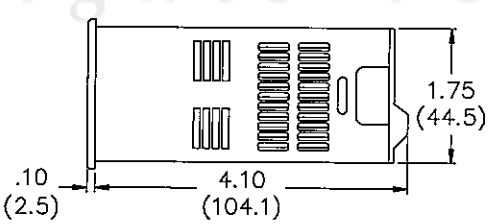
CAUTION: Risk of Danger
Read complete instructions prior to installation and operation of the unit.

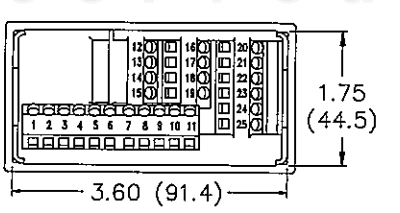
CAUTION: Risk of electric shock.

DIMENSIONS In inches (mm)

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.4) H x 5.0" (127) W.







MODEL PAXS - SMART STRAIN GAGE METER

Output Specifications Continued

Working Voltage: 240 Vrms
Contact Rating:
One Relay Energized: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @120 VAC, inductive load
Total current with both relays energized not to exceed 5 amps
Life Expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

Quad Relay Card:
Type: Four FORM-A relays
Isolation To Sensor & User Input Commons: 2300 Vrms for 1 min.
Working Voltage: 250 Vrms
Contact Rating:
One Relay Energized: 3 amps @ 250 VAC or 30 VDC (resistive load), 1/10 HP @120 VAC, inductive load
Total current with all four relays energized not to exceed 4 amps
Life Expectancy: 100K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

Quad Sinking Open Collector Card:
Type: Four isolated sinking NPN transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Rating: 100 mA max @ V_{SAT} = 0.7 V max. V_{MAX} = 30 V
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

Quad Sourcing Open Collector Card:
Type: Four isolated sourcing PNP transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V Not Isolated from all other commons.
Rating: Internal supply: 24 VDC ± 10% , 30 mA max. total
External supply: 30 VDC max., 100 mA max. each output
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

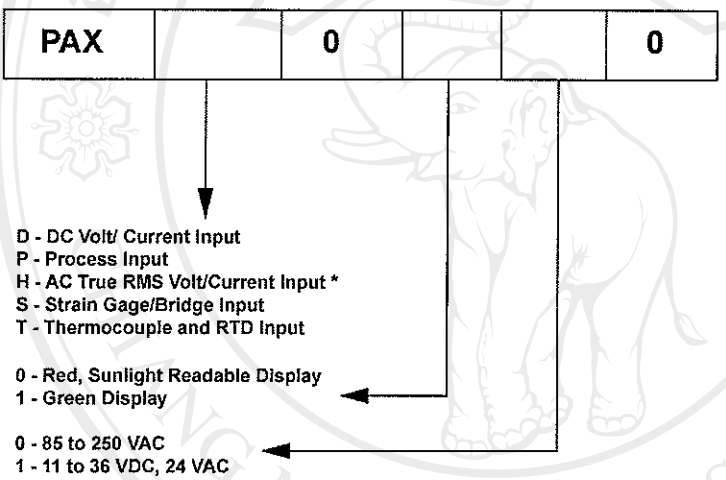
Ordering Information

TYPE	MODEL NO.	DESCRIPTION	PART NUMBERS
Meter	PAXS	Strain Bridge Input Panel Meter, Upgradeable, AC Powered	PAXS0000
		Strain Bridge Input Panel Meter, Upgradeable, DC Powered	PAXS0010
Optional Plug-In Cards	PAXCDS	Dual Setpoint Relay Output Card	PAXCDS10
		Quad Setpoint Relay Output Card	PAXCDS20
		Quad Setpoint Sinking Open Collector Output Card	PAXCDS30
		Quad Setpoint Sourcing Open Collector Output Card	PAXCDS40
	PAXCDC	RS485 Serial Communications Card	PAXCDC10
		RS232 Serial Communications Card	PAXCDC20
		DeviceNET Communications Card	PAXCDC30
	PAXCDL	Analog Output Card	PAXCDL10
Accessories	PAXLBK	Units Label Kit Accessory	PAXLBK10
	SFPAX	PC Configuration Software for Windows 3.x and 95 (3.5" disk)	SFPAX

TABLE OF CONTENTS

ORDERING INFORMATION

Meter Part Numbers



* PAXH is only available with 85-250 VAC power supply.

Option Card and Accessories Part Numbers

TYPE	MODEL NO.	DESCRIPTION	PART NUMBERS
Optional Plug-In Cards	PAXCDS	Dual Setpoint Relay Output Card	PAXCDS10
		Quad Setpoint Relay Output Card	PAXCDS20
		Quad Setpoint Sinking Open Collector Output Card	PAXCDS30
		Quad Setpoint Sourcing Open Collector Output Card	PAXCDS40
	PAXCDC	RS485 Serial Communications Output Card with Terminal Block	PAXCDC10
		Extended RS485 Serial Communications Output Card with Dual RJ11 Connector	PAXCDC1C
		RS232 Serial Communications Output Card with Terminal Block	PAXCDC20
		Extended RS232 Serial Communications Output Card with 9 Pin D Connector	PAXCDC2C
		DeviceNet Communications Card	PAXCDC30
		Modbus Communications Card	PAXCDC40
		Extended Modbus Communications Card with Dual RJ11 Connector	PAXCDC4C
		Profibus-DP Communications Card	PAXCDC50
	PAXCDL	Analog Output Card	PAXCDL10
Accessories	PAXLBK	Units Label Kit Accessory (Not required for PAXT)	PAXLBK10
	SFCRD*	Crimson 2 PC Configuration Software for Windows 98, ME, 2000 and XP	SFCRD200

Crimson software is available for download from http://www.redlion.net/

GENERAL METER SPECIFICATIONS

1. **DISPLAY**: 5 digit, 0.56" (14.2 mm) red sunlight readable or standard green LEDs, (-19999 to 99999)
2. **POWER**:
   AC Versions:
   AC Power: 85 to 250 VAC, 50/60 Hz, 15 VA
   Isolation: 2300 Vrms for 1 min. to all inputs and outputs.
   DC Versions (Not available on PAXH):
   DC Power: 11 to 36 VDC, 11 W
   (derate operating temperature to 40° C if operating <15 VDC and three plug-in option cards are installed)
   AC Power: 24 VAC, ± 10%, 50/60 Hz, 15 VA
   Isolation: 500 Vrms for 1 min. to all inputs and outputs (50 V working).
3. **ANNUNCIATORS**:
   MAX - maximum readout selected
   MIN - minimum readout selected
   TOT - totalizer readout selected, flashes when total overflows
   SP1 - setpoint alarm 1 is active
   SP2 - setpoint alarm 2 is active
   SP3 - setpoint alarm 3 is active
   SP4 - setpoint alarm 4 is active
   Units Label - optional units label backlight
4. **KEYPAD**: 3 programmable function keys, 5 keys total
5. **A/D CONVERTER**: 16 bit resolution
6. **UPDATE RATES**:
   A/D conversion rate: 20 readings/sec.
   Step response: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
   700 msec. max. (digital filter disabled, internal zero correction enabled)
   PAXH Only: 1 sec max. to within 99% of final readout value (digital filter disabled)
   Display update rate: 1 to 20 updates/sec.
   Setpoint output on/off delay time: 0 to 3275 sec.
   Analog output update rate: 0 to 10 sec
   Max./Min. capture delay time: 0 to 3275 sec.
7. **DISPLAY MESSAGES**:
   "OLOL" - Appears when measurement exceeds + signal range.
   "ULUL" - Appears when measurement exceeds - signal range
   PAXT: "SHrt" - Appears when shorted sensor is detected. (RTD only)
   PAXT: "OPEN" - Appears when open sensor is detected
   ". . ." - Appears when display values exceed + display range.
   "- . . ." - Appears when display values exceed - display range.
8. **INPUT CAPABILITIES**: See specific product specifications, pages 4-6
9. **EXCITATION POWER**: See specific product specifications, pages 4-6
10. **LOW FREQUENCY NOISE REJECTION**: (Does not apply to PAXH)
    Normal Mode: > 60 dB @ 50 or 60 Hz ±1%, digital filter off
    Common Mode: >100 dB, DC to 120 Hz
11. **USER INPUTS**: Three programmable user inputs
    Max. Continuous Input: 30 VDC
    Isolation To Sensor Input Common: Not isolated. (Not PAXH)
    PAXH: Isolation to Sensor Input Common: 1400 Vrms for 1 min.
    Working Voltage: 125 V
    Response Time: 50 msec. max.
    Logic State: Jumper selectable for sink/source logic

INPUT STATE	SINKING INPUTS 22 KΩ pull-up to +5 V	SOURCING INPUTS 22 KΩ pull-down
Active	V_{IN} < 0.9 VDC	V_{IN} > 3.6 VDC
Inactive	V_{IN} > 3.6 VDC	V_{IN} < 0.9 VDC

12. **TOTALIZER**:
    Function:
    Time Base: second, minute, hour, or day
    Batch: Can accumulate (gate) input display from a user input
    Time Accuracy: 0.01% typical
    Decimal Point: 0 to 0.0000
    Scale Factor: 0.001 to 65.000
    Low Signal Cut-out: -19,999 to 99,999
    Total: 9 digits, display alternates between high order and low order readouts
13. **CUSTOM LINEARIZATION**:
    Data Point Pairs: Selectable from 2 to 16
    Display Range: -19,999 to 99,999
    Decimal Point: 0 to 0.0000
    PAXT: Ice Point Compensation: user value (0.00 to 650.00 µV/°C)
14. **MEMORY**: Nonvolatile E^2PROM retains all programmable parameters and display values.
15. **ENVIRONMENTAL CONDITIONS**:
    Operating Temperature Range: 0 to 50°C (0 to 45°C with all three plug-in cards installed)
    Vibration According to IEC 68-2-6: 5 to 150 Hz, in X, Y, Z direction for 1.5 hours, 2g's.
    Shock According to IEC 68-2-27: Operational 25 g (10g relay), 11 msec in 3 directions.
    Storage Temperature Range: -40 to 60°C
    Operating and Storage Humidity: 0 to 85% max. RH non-condensing
    Altitude: Up to 2000 meters
16. **CERTIFICATIONS AND COMPLIANCES**:
    SAFETY
    UL Recognized Component, File #E179259, UL61010A-1, CSA C22.2 No. 1010-1
    PAXT Only: File # E156876, UL873, CSA C22.2 No. 24
    Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
    UL Listed, File # E137808, UL508, CSA C22.2 No. 14-M95
    LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
    Type 4X Enclosure rating (Face only), UL50
    IECEE CB Scheme Test Certificate #US/8843A/UL
    CB Scheme Test Report #04ME11209-20041018
    Issued by Underwriters Laboratories, Inc.
    IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part I
    IP65 Enclosure rating (Face only), IEC 529
    IP20 Enclosure rating (Rear of unit), IEC 529

    ELECTROMAGNETIC COMPATIBILITY

Immunity to EN 50082-2		
Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m [1] 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms 150 KHz - 80 MHz
Simulation of cordless telephones	ENV 50204	Level 3; 10 V/m 900 MHz ±5 MHz 200 Hz, 50% duty cycle
Emissions to EN 50081-2		
RF interference	EN 55011	Enclosure class A Power mains class A

Notes:
1. Self-recoverable loss of performance during EMI disturbance at 10 V/m: Measurement input and/or analog output signal may deviate during EMI disturbance.
For operation without loss of performance:
Unit is mounted in a metal enclosure (Buckeye SM7013-0 or equivalent)
I/O and power cables are routed in metal conduit connected to earth ground.
Refer to EMC Installation Guidelines section of the bulletin for additional information.

17. **CONNECTIONS**: High compression cage-clamp terminal block
    Wire Strip Length: 0.3" (7.5 mm)
    Wire Gage: 30-14 AWG copper wire
    Torque: 4.5 inch-lbs (0.51 N-m) max.
18. **CONSTRUCTION**: This unit is rated for NEMA 4X/IP65 outdoor use. IP20 Touch safe. Installation Category II, Pollution Degree 2. One piece bezel/case. Flame resistant. Synthetic rubber keypad. Panel gasket and mounting clip included.
19. **WEIGHT**: 10.4 oz. (295 g)

MODEL PAXD - UNIVERSAL DC INPUT

- *FOUR VOLTAGE RANGES (300 VDC Max)*
- *FIVE CURRENT RANGES (2A DC Max)*
- *THREE RESISTANCE RANGES (10K Ohm Max)*
- *SELECTABLE 24 V, 2 V, 1.75 mA EXCITATION*

PAXD SPECIFICATIONS

INPUT RANGES:

INPUT RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE/ COMPLIANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
±200 µADC	0.03% of reading +0.03 µA	0.12% of reading +0.04µA	1.11 Kohm	15 mA	10 nA
±2 mADC	0.03% of reading +0.3 µA	0.12% of reading +0.4 µA	111 ohm	50 mA	0.1 µA
±20 mADC	0.03% of reading +3µA	0.12% of reading +4 µA	11.1 ohm	150 mA	1 µA
±200 mADC	0.05% of reading +30 µA	0.15% of reading +40 µA	1.1 ohm	500 mA	10 µA
±2 ADC	0.5% of reading +0.3 mA	0.7% of reading +0.4 mA	0.1 ohm	3 A	0.1 mA
±200 mVDC	0.03% of reading +30 µV	0.12% of reading +40 µV	1.066 Mohm	100 V	10 µV
±2 VDC	0.03% of reading +0.3 mV	0.12% of reading +0.4 mV	1.066 Mohm	300 V	0.1 mV
±20 VDC	0.03% of reading +3 mV	0.12% of reading +4 mV	1.066 Mohm	300 V	1 mV
±300 VDC	0.05% of reading +30 mV	0.15% of reading +40 mV	1.066 Mohm	300 V	10 mV
100 ohm	0.05% of reading +30 Mohm	0.2% of reading +40 Mohm	0.175 V	30 V	0.01 ohm
1000 ohm	0.05% of reading +0.3 ohm	0.2% of reading +0.4 ohm	1.75 V	30 V	0.1 ohm
10 Kohm	0.05% of reading +1 ohm	0.2% of reading +1.5 ohm	17.5 V	30 V	1 ohm

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85% RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

EXCITATION POWER:

Transmitter Power: 24 VDC, ±5%, regulated, 50 mA max.
Reference Voltage: 2 VDC, ± 2%
Compliance: 1 kohm load min. (2 mA max.)
Temperature coefficient: 40 ppm/°C max.
Reference Current: 1.75 mADC, ± 2%
Compliance: 10 kohm load max.
Temperature coefficient: 40 ppm/°C max.

MODEL PAXP - PROCESS INPUT

- *DUAL RANGE INPUT (20 mA or 10 VDC)*
- *24 VDC TRANSMITTER POWER*

PAXP SPECIFICATIONS

SENSOR INPUTS:

INPUT (RANGE)	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE/ COMPLIANCE	MAX CONTINUOUS OVERLOAD	DISPLAY RESOLUTION
20 mA (-2 to 26 mA)	0.03% of reading +2 µA	0.12% of reading +3 µA	20 ohm	150 mA	1 µA
10 VDC (-1 to 13 VDC)	0.03% of reading +2 mV	0.12% of reading +3 mV	500 Kohm	300 V	1 mV

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85%RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

EXCITATION POWER:

Transmitter Power: 24 VDC, ±5%, regulated, 50 mA max.

MODEL PAXH - AC TRUE RMS VOLT AND CURRENT

- *FOUR VOLTAGE RANGES (300 VAC Max)*
- *FIVE CURRENT RANGES (5 A Max)*
- *ACCEPTS AC OR DC COUPLED INPUTS*
- *THREE WAY ISOLATION: POWER, INPUT AND OUTPUTS*

PAXH SPECIFICATIONS

INPUT RANGES:

⚠ Isolation To Option Card Commons and User Input Commons: 125 Vrms
Isolation To AC Power Terminals: 250 Vrms

INPUT RANGE	ACCURACY*	IMPEDANCE (60 Hz)	MAX CONTINUOUS OVERLOAD	MAX DC BLOCKING	RESOLUTION
200 mV	0.1% of reading +0.4 mV	686 Kohm	30 V	±10 V	0.01 mV
2 V	0.1% of reading +2 mV	686 Kohm	30 V	±50 V	0.1 mV
20 V	0.1% of reading +20 mV	686 Kohm	300 V	±300 V	1 mV
300 V	0.2% of reading +0.3 V	686 Kohm	300 V	±300 V***	0.1 V
200 µA	0.1% of reading +0.4 µA	1.11 Kohm	15 mA	±15 mA	0.01 µA
2 mA	0.1% of reading +2 µA	111 ohm	50 mA	±50 mA	0.1 µA
20 mA	0.1% of reading +20 µA	11.1 ohm	150 mA	±150 mA	1 µA
200 mA	0.1% of reading +0.2 mA	1.1 ohm	500 mA	±500 mA	10 µA
5 A	0.5% of reading +5 mA	0.02 ohm	7 A**	±7 A***	1 mA

*Conditions for accuracy specification:
- 20 minutes warmup
- 18-28°C temperature range, 10-75% RH non-condensing
- 50 Hz - 400 Hz sine wave input
- 1% to 100% of range
- Add 0.1% reading + 20 counts error over 0-50°C range
- Add 0.2% reading + 10 counts error for crest factors up to 3, add 1% reading up to 5
- Add 0.5% reading + 10 counts of DC component
- Add 1% reading + 20 counts error over 20 Hz to 10 KHz range

** Non-repetitive surge rating: 15 A for 5 seconds

*** Inputs are direct coupled to the input divider and shunts. Input signals with high DC component levels may reduce the usable range.

MAX CREST FACTOR (Vp/VRMS): 5 @ Full Scale Input
INPUT COUPLING: AC or AC and DC
INPUT CAPACITANCE: 10 pF
COMMON MODE VOLTAGE: 125 VAC working
COMMON MODE REJECTION: (DC to 60 Hz) 100 dB

MODEL PAXS - STRAIN GAGE INPUT

- *LOAD CELL, PRESSURE AND TORQUE BRIDGE INPUTS*
- *DUAL RANGE INPUT: ±24 mV OR ±240 mV*
- *SELECTABLE 5 VDC OR 10 VDC BRIDGE EXCITATION*
- *PROGRAMMABLE AUTO-ZERO TRACKING*

PAXS SPECIFICATIONS

SENSOR INPUTS:

INPUT RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	IMPEDANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
±24 mVDC	0.02% of reading +3 µV	0.07% of reading +4 µV	100 Mohm	30 V	1 µV
±240 mVDC	0.02% of reading +30 µV	0.07% of reading +40 µV	100 Mohm	30 V	10 µV

* After 20 minute warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 10 to 75% RH environment; and accuracy over a 0 to 50°C and 0 to 85% RH (non-condensing environment). Accuracy over the 0 to 50°C range includes the temperature coefficient effect of the meter.

CONNECTION TYPE: 4-wire bridge (differential)
2-wire (single-ended)
COMMON MODE RANGE (w.r.t. input common): 0 to +5 VDC
Rejection: 80 dB (DC to 120 Hz)
BRIDGE EXCITATION :
Jumper Selectable: 5 VDC @ 65 mA max., ±2%
10 VDC @ 125 mA max., ±2%
Temperature coefficient (ratio metric): 20 ppm/°C max.

MODEL PAXT - THERMOCOUPLE AND RTD INPUT

- *THERMOCOUPLE AND RTD INPUTS*
- *CONFORMS TO ITS-90 STANDARDS*
- *CUSTOM SCALING FOR NON-STANDARD PROBES*
- *TIME-TEMPERATURE INTEGRATOR*

PAXT SPECIFICATIONS

READOUT:
Resolution: Variable: 0.1, 0.2, 0.5, or 1, 2, or 5 degrees
Scale: F or C
Offset Range: -19,999 to 99,999 display units

THERMOCOUPLE INPUTS:
Input Impedance: 20 MΩ
Lead Resistance Effect: 0.03μV/ohm
Max. Continuous Overvoltage: 30 V

INPUT TYPE	RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	STANDARD	WIRE COLOR	
					ANSI	BS 1843
T	-200 to 400°C -270 to -200°C	1.2°C **	2.1°C	ITS-90	(+) blue (-) red	(+) white (-) blue
E	-200 to 871°C -270 to -200°C	1.0°C **	2.4°C	ITS-90	(+) purple (-) red	(+) brown (-) blue
J	-200 to 760°C	1.1°C	2.3°C	ITS-90	(+) white (-) red	(+) yellow (-) blue
K	-200 to 1372°C -270 to -200°C	1.3°C **	3.4°C	ITS-90	(+) yellow (-) red	(+) brown (-) blue
R	-50 to 1768°C	1.9°C	4.0°C	ITS-90	no standard	(+) white (-) blue
S	-50 to 1768°C	1.9°C	4.0°C	ITS-90	no standard	(+) white (-) blue
B	100 to 300°C 300 to 1820°C	3.9°C 2.8°C	5.7°C 4.4°C	ITS-90	no standard	no standard
N	-200 to 1300°C -270 to -200°C	1.3°C **	3.1°C	ITS-90	(+) orange (-) red	(+) orange (-) blue
C (W5/W26)	0 to 2315°C	1.9°C	6.1°C	ASTM E988-90***	no standard	no standard

*After 20 min. warm-up. Accuracy is specified in two ways: Accuracy over an 18 to 28°C and 15 to 75% RH environment; and Accuracy over a 0 to 50°C and 0 to 85% RH (non condensing) environment. Accuracy specified over the 0 to 50°C operating range includes meter tempco and ice point tracking effects. The specification includes the A/D conversion errors, linearization conformity, and thermocouple ice point compensation. Total system accuracy is the sum of meter and probe errors. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

** The accuracy over the interval -270 to -200°C is a function of temperature, ranging from 1°C at -200°C and degrading to 7°C at -270°C. Accuracy may be improved by field calibrating the meter readout at the temperature of interest.

*** These curves have been corrected to ITS-90.

RTD INPUTS:
Type: 3 or 4 wire, 2 wire can be compensated for lead wire resistance
Excitation current: 100 ohm range: 165 μA
10 ohm range: 2.6 mA
Lead resistance: 100 ohm range: 10 ohm/lead max.
10 ohm range: 3 ohms/lead max.
Max. continuous overload: 30 V

INPUT TYPE	RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)	STANDARD ***
100 ohm Pt alpha = .00385	-200 to 850°C	0.4°C	1.6°C	IEC 751
100 ohm Pt alpha = .003919	-200 to 850°C	0.4°C	1.6°C	no official standard
120 ohm Nickel alpha = .00672	-80 to 260°C	0.2°C	0.5°C	no official standard
10 ohm Copper alpha = .00427	-100 to 260°C	0.4°C	0.9°C	no official standard

CUSTOM RANGE: Up to 16 data point pairs
Input range: -10 to 65 mV
0 to 400 ohms, high range
0 to 25 ohms, low range
Display range: -19999 to 99999

INPUT TYPE	RANGE	ACCURACY* (18 to 28°C)	ACCURACY* (0 to 50°C)
Custom mV range	-10 to 65mV (1 μV res.)	0.02% of reading + 4μV	0.12% of reading + 5μV
Custom 100 ohm range	0 to 400 Ω (10 MΩ res.)	0.02% of reading + 0.04 Ω	0.12% of reading + 0.05 Ω
Custom 10 ohm range	0 to 25 Ω (1 MΩ res.)	0.04% of reading + 0.005 Ω	0.20% of reading + 0.007 Ω

ACCESSORIES

UNITS LABEL KIT (PAXLBK) - Not required for PAXT

Each meter has a units indicator with backlighting that can be customized using the Units Label Kit. The backlight is controlled in the programming.

Each PAXT meter is shipped with °F and °C overlay labels which can be installed into the meter's bezel display assembly.

EXTERNAL CURRENT SHUNTS (APSCM)

To measure DC current signals greater than 2 ADC, a shunt must be used. The APSCM010 current shunt converts a maximum 10 ADC signal into 10.0 mV. The APSCM100 current shunt converts a maximum 100 ADC signal into 100.0 mV. The continuous current through the shunt is limited to 115% of the rating.

OPTIONAL PLUG-IN OUTPUT CARDS

WARNING: Disconnect all power to the unit before installing Plug-in cards.

Adding Option Cards

The PAX and MPAX series meters can be fitted with up to three optional plug-in cards. The details for each plug-in card can be reviewed in the specification section below. Only one card from each function type can be installed at one time. The function types include Setpoint Alarms (PAXCDS), Communications (PAXCDC), and Analog Output (PAXCDL). The plug-in cards can be installed initially or at a later date.

PAXH Isolation Specifications For All Option Cards

Isolation To Sensor Commons: 1400 Vrms for 1 min.
Working Voltage: 125 V
Isolation to User Input Commons: 500 Vrms for 1 min.
Working Voltage 50 V

COMMUNICATION CARDS (PAXCDC)

A variety of communication protocols are available for the PAX and MPAX series. Only one of these cards can be installed at a time. When programming the unit via RLCPro, a Windows® based program, the RS232 or RS485 Cards must be used.

PAXCDC10 - RS485 Serial
PAXCDC20 - RS232 Serial
PAXCDC30 - DeviceNet
PAXCDC40 - Modbus
PAXCDC50 - Profibus-DP

SERIAL COMMUNICATIONS CARD
Type: RS485 or RS232
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Data: 7/8 bits
Baud: 300 to 19,200
Parity: no, odd or even
Bus Address: Selectable 0 to 99, Max. 32 meters per line (RS485)
Transmit Delay: Selectable for 2 to 50 msec or 50 to 100 msec (RS485)

DEVICENET™ CARD
Compatibility: Group 2 Server Only, not UCMM capable
Baud Rates: 125 Kbaud, 250 Kbaud, and 500 Kbaud
Bus Interface: Phillips 82C250 or equivalent with MIS wiring protection per DeviceNet™ Volume I Section 10.2.2.
Node Isolation: Bus powered, isolated node
Host Isolation: 500 Vrms for 1 minute (50 V working) between DeviceNet™ and meter input common.

MODBUS CARD
Type: RS485; RTU and ASCII MODBUS modes
Isolation To Sensor & User Input Commons: 500 Vrms for 1 minute.
Working Voltage: 50 V. Not isolated from all other commons.
Baud Rates: 300 to 38400.
Data: 7/8 bits
Parity: No, Odd, or Even
Addresses: 1 to 247.
Transmit Delay: Programmable; See Transmit Delay explanation.

PROFIBUS-DP CARD
Fieldbus Type: Profibus-DP as per EN 50170, implemented with Siemens SPC3 ASIC
Conformance: PNO Certified Profibus-DP Slave Device
Baud Rates: Automatic baud rate detection in the range 9.6 Kbaud to 12 Mbaud
Station Address: 0 to 126, set by the master over the network. Address stored in non-volatile memory.
Connection: 9-pin Female D-Sub connector
Network Isolation: 500 Vrms for 1 minute (50 V working) between Profibus network and sensor and user input commons. Not isolated from all other commons.

PROGRAMMING SOFTWARE

Crimson is a Windows® based program that allows configuration of the PAX meter from a PC. Crimson offers standard drop-down menu commands, that make it easy to program the PAX meter. The PAX program can then be saved in a PC file for future use. A PAX serial plug-in card is required to program the meter using the software.

SETPOINT CARDS (PAXCDS)

The PAX and MPAX series has 4 available setpoint alarm output plug-in cards. Only one of these cards can be installed at a time. (Logic state of the outputs can be reversed in the programming.) These plug-in cards include:

PAXCDS10 - Dual Relay, FORM-C, Normally open & closed
PAXCDS20 - Quad Relay, FORM-A, Normally open only
PAXCDS30 - Isolated quad sinking NPN open collector
PAXCDS40 - Isolated quad sourcing PNP open collector

DUAL RELAY CARD
Type: Two FORM-C relays
Isolation To Sensor & User Input Commons: 2000 Vrms for 1 min.
Working Voltage: 240 Vrms
Contact Rating:
One Relay Energized: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @120 VAC, inductive load
Total current with both relays energized not to exceed 5 amps
Life Expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

QUAD RELAY CARD
Type: Four FORM-A relays
Isolation To Sensor & User Input Commons: 2300 Vrms for 1 min.
Working Voltage: 250 Vrms
Contact Rating:
One Relay Energized: 3 amps @ 240 VAC or 30 VDC (resistive load), 1/10 HP @120 VAC, inductive load
Total current with all four relays energized not to exceed 4 amps
Life Expectancy: 100K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

QUAD SINKING OPEN COLLECTOR CARD
Type: Four isolated sinking NPN transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Rating: 100 mA max @ V_{SAT} = 0.7 V max. V_{MAX} = 30 V

QUAD SOURCING OPEN COLLECTOR CARD
Type: Four isolated sourcing PNP transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Rating: Internal supply: 24 VDC ± 10% , 30 mA max. total
External supply: 30 VDC max., 100 mA max. each output

ALL FOUR SETPOINT CARDS
Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

LINEAR DC OUTPUT (PAXCDL)

Either a 0(4)-20 mA or 0-10 V retransmitted linear DC output is available from the analog output plug-in card. The programmable output low and high scaling can be based on various display values. Reverse slope output is possible by reversing the scaling point positions.

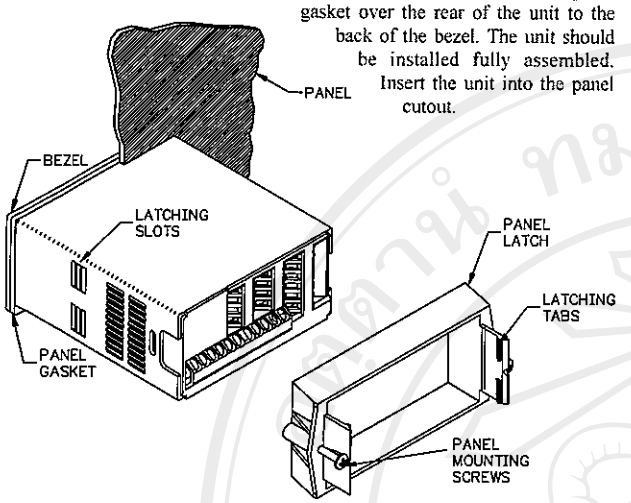
PAXCDL10 - Retransmitted Analog Output Card

ANALOG OUTPUT CARD
Types: 0 to 20 mA, 4 to 20 mA or 0 to 10 VDC
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Accuracy: 0.17% of FS (18 to 28°C); 0.4% of FS (0 to 50°C)
Resolution: 1/3500
Compliance: 10 VDC: 10 KΩ load min., 20 mA: 500 Ω load max.
Update time: 200 msec. max. to within 99% of final output value (digital filter and internal zero correction disabled)
700 msec. max. (digital filter disabled, internal zero correction enabled)

1.0 INSTALLING THE METER

Installation

The PAX meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.



While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch screws evenly until the unit is snug in the panel (Torque to approximately 7 in-lbs [79N-cm]). Do not over-tighten the screws.

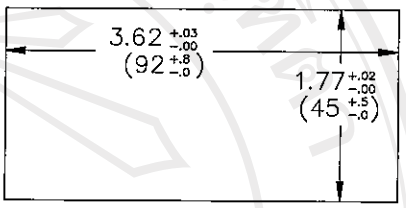
Installation Environment

The unit should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should be cleaned only with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.

PANEL CUT-OUT



2.0 SETTING THE JUMPERS

The meter can have up to four jumpers that must be checked and / or changed prior to applying power. The following Jumper Selection Figures show an enlargement of the jumper area.

To access the jumpers, remove the meter base from the case by firmly squeezing and pulling back on the side rear finger tabs. This should lower the latch below the case slot (which is located just in front of the finger tabs). It is recommended to release the latch on one side, then start the other side latch.

Input Range Jumper

This jumper is used to select the proper input range. The input range selected in programming must match the jumper setting. Select a range that is high enough to accommodate the maximum input to avoid overloads. The selection is different for each meter. See the Jumper Selection Figure for appropriate meter.

Excitation Output Jumper

If your meter has excitation, this jumper is used to select the excitation range for the application. If excitation is not being used, it is not necessary to check or move this jumper.

User Input Logic Jumper

This jumper selects the logic state of all the user inputs. If the user inputs are not used, it is not necessary to check or move this jumper.

PAXH:

Signal Jumper

This jumper is used to select the signal type. For current signals, the jumper is installed. For voltage signals, remove the jumper from the board. (For 2 V inputs, this removed jumper can be used in the "2 V only" location.)

Couple Jumper

This jumper is used for AC / DC couple. If AC couple, then the jumper is removed from the board. If DC couple is used, then the jumper is installed.

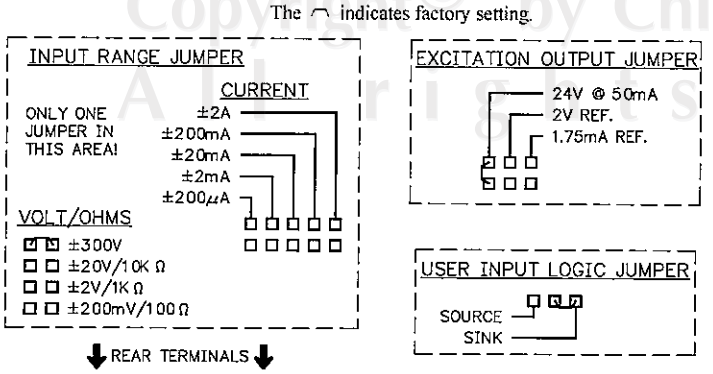
PAXD Jumper Selection

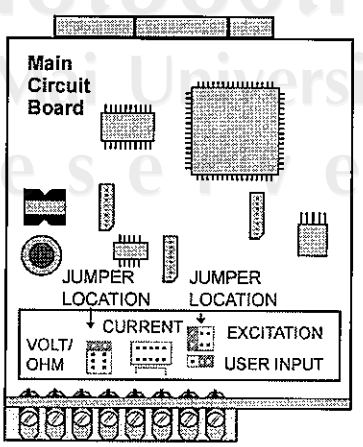
Input Range Jumper

One jumper is used for voltage/ohms or current input ranges. Select the proper input range high enough to avoid input signal overload. Only one jumper is allowed in this area. Do not have a jumper in both the voltage and current ranges at the same time. Avoid placing the jumper across two ranges.

JUMPER SELECTIONS

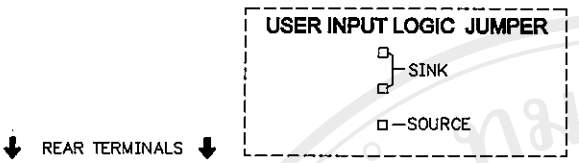
The ⌒ indicates factory setting.

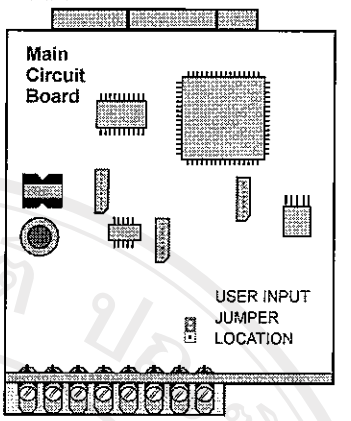




PAXP Jumper Selection

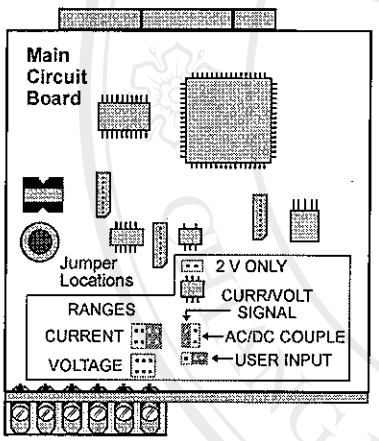
JUMPER SELECTIONS
The ⌒ indicates factory setting.



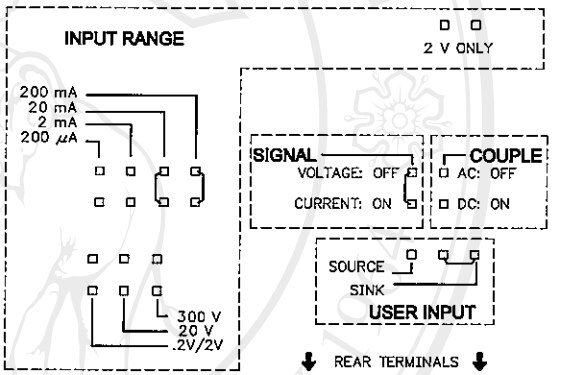


PAXH Jumper Selection

CAUTION: To maintain the electrical safety of the meter, remove unneeded jumpers completely from the meter. Do not move the jumpers to positions other than those specified.



JUMPER SELECTIONS
The ⌒ indicates factory setting.



Signal Jumper

One jumper is used for the input signal type. For current signals, the jumper is installed. For voltage signals, remove the jumper from the board. (For 2 V inputs, this removed jumper can be used in the "2 V only" location.)

Couple Jumper

One jumper is used for AC / DC couple. If AC couple is used, then the jumper is removed from the board. If DC couple is used, then the jumper is installed.

Input Range Jumper

For most inputs, one jumper is used to select the input range. However, for the following ranges, set the jumpers as stated:

5 A: Remove all jumpers from the input range.

2 V: Install one jumper in ".2/2V" position and one jumper in "2 V only".

All Other Ranges: One jumper in the selected range only.

Do not have a jumper in both the voltage and current ranges at the same time. Avoid placing a jumper across two ranges.

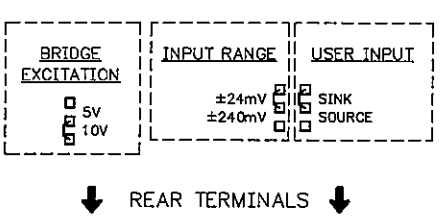
PAXS Jumper Selection

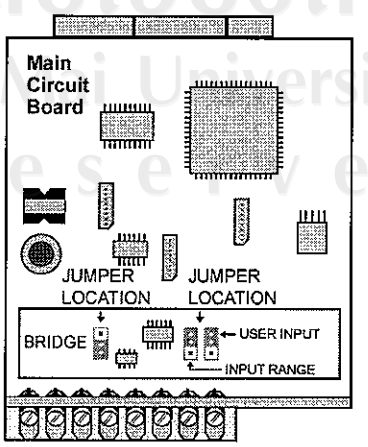
Bridge Excitation

One jumper is used to select bridge excitation to allow use of the higher sensitivity 24 mV input range. Use the 5 V excitation with high output (3 mV/V) bridges. The 5 V excitation also reduces bridge power compared to 10 V excitation.

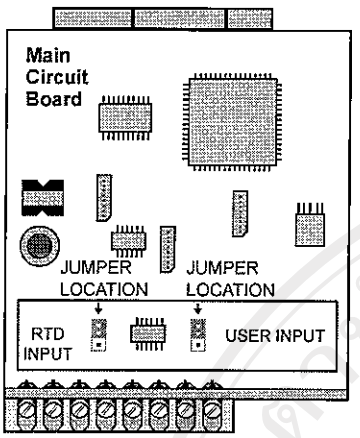
A maximum of four 350 ohm load cells can be driven by the internal bridge excitation voltage.

JUMPER SELECTIONS
The ⌒ indicates factory setting.





PAXT Jumper Selection

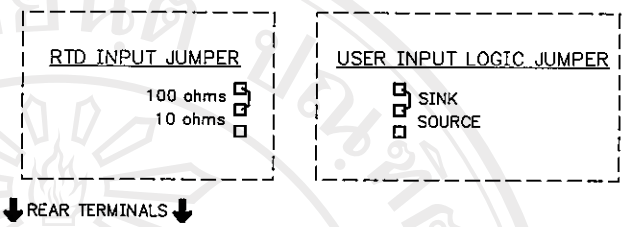


RTD Input Jumper

One jumper is used for RTD input ranges. Select the proper range to match the RTD probe being used. It is not necessary to remove this jumper when not using RTD probes.

JUMPER SELECTIONS

The ⌒ indicates factory setting.



3.0 WIRING THE METER

WIRING OVERVIEW

Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter's voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power supplied to the meter (DC or AC) be protected by a fuse or circuit breaker.

When wiring the meter, compare the numbers embossed on the back of the meter case against those shown in wiring drawings for proper wire position. Strip the wire, leaving approximately 0.3" (7.5 mm) bare lead exposed (stranded wires should be tinned with solder). Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.) Each terminal can accept up to one #14 AWG (2.55 mm) wire, two #18 AWG (1.02 mm), or four #20 AWG (0.61 mm).

EMC INSTALLATION GUIDELINES

Although this meter is designed with a high degree of immunity to Electro-Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, its source or the method of coupling into the unit may be different for various installations.Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The meter should be mounted in a metal enclosure, which is properly connected to protective earth.
2. With use of the lower input ranges or signal sources with high source impedance, the use of shielded cable may be necessary. This helps to guard against stray AC pick-up. Attach the shield to the input common of the meter. Line voltage monitoring and 5A CT applications do not usually require shielding.
3. To minimize potential noise problems, power the meter from the same power branch, or at least the same phase voltage as that of the signal source.
4. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
5. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.
6. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:

   Ferrite Suppression Cores for signal and control cables:
   Fair-Rite # 0443167251 (RLC #FCOR0000)
   TDK # ZCAT3035-1330A
   Steward #28B2029-0A0

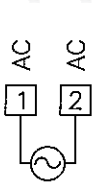
   Line Filters for input power cables:
   Schaffner # FN610-1/07 (RLC #LFIL0000)
   Schaffner # FN670-1.8/07
   Corcom #1VR3

   Note: Reference manufacturer's instructions when installing a line filter.
7. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
8. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.

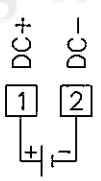
   Snubber: RLC#SNUB0000.

3.1 POWER WIRING

AC Power
Terminal 1: VAC
Terminal 2: VAC



DC Power
Terminal 1: +VDC
Terminal 2: -VDC

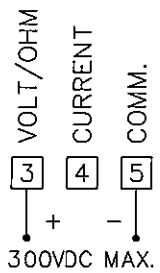


3.2 INPUT SIGNAL WIRING

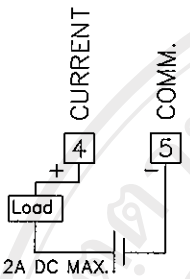
PAXD INPUT SIGNAL WIRING

Before connecting signal wires, the Input Range Jumper and Excitation Jumper should be verified for proper position.

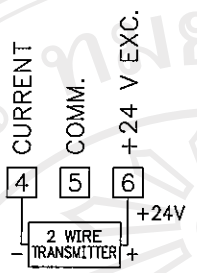
Voltage Signal (self powered)
Terminal 3: +VDC
Terminal 5: -VDC



Current Signal (self powered)
Terminal 4: +ADC
Terminal 5: -ADC

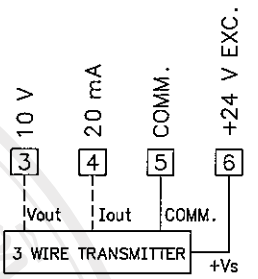


Current Signal (2 wire requiring excitation)
Terminal 4: -ADC
Terminal 6: +ADC
Excitation Jumper: 24 V

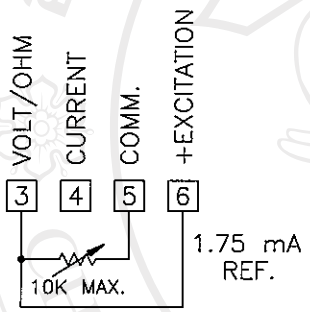


Current Signal (3 wire requiring excitation)
Terminal 4: +ADC (signal)
Terminal 5: -ADC (common)
Terminal 6: +Volt supply
Excitation Jumper: 24 V

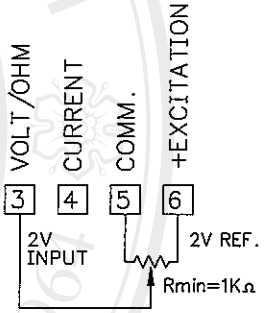
Voltage Signal (3 wire requiring excitation)
Terminal 3: +VDC (signal)
Terminal 5: -VDC (common)
Terminal 6: +Volt supply
Excitation Jumper: 24 V



Resistance Signal (3 wire requiring excitation)
Terminal 3: Resistance
Terminal 5: Resistance
Terminal 6: Jumper to terminal 3
Excitation Jumper: 1.75 mA REF.



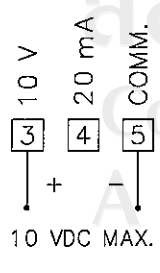
Potentiometer Signal (3 wire requiring excitation)
Terminal 3: Wiper
Terminal 5: Low end of pot.
Terminal 6: High end of pot.
Excitation Jumper: 2 V REF.
Input Range Jumper: 2 Volt
Module I Input Range: 2 Volt
Note: The Apply signal scaling style should be used because the signal will be in volts.



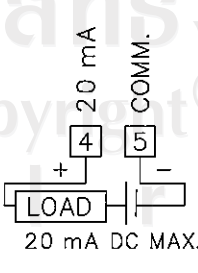
CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

PAXP INPUT SIGNAL WIRING

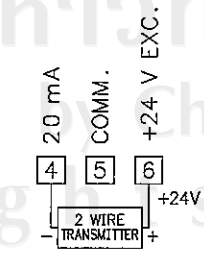
Voltage Signal (self powered)
Terminal 3: +VDC
Terminal 5: -VDC



Current Signal (self powered)
Terminal 4: +ADC
Terminal 5: -ADC

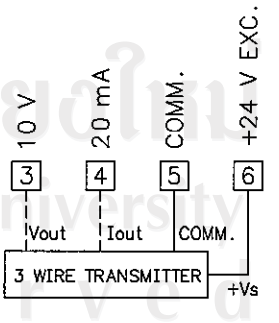


Current Signal (2 wire requiring excitation)
Terminal 4: -ADC
Terminal 6: +ADC



Current Signal (3 wire requiring excitation)
Terminal 4: +ADC (signal)
Terminal 5: -ADC (common)
Terminal 6: +Volt supply

Voltage Signal (3 wire requiring excitation)
Terminal 3: +VDC (signal)
Terminal 5: -VDC (common)
Terminal 6: +Volt supply

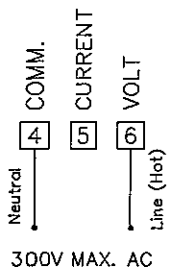


CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

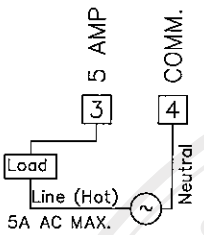
PAXH INPUT SIGNAL WIRING

Before connecting signal wires, the Signal, Input Range and Couple Jumpers should be verified for proper position.

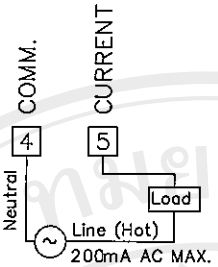
Voltage Signal



Current Signal (Amps)



Current Signal (Milliamps)



CAUTION: Connect only one input signal range to the meter. Hazardous signal levels may be present on unused inputs.

CAUTION: The isolation rating of the input common of the meter with respect to the option card commons and the user input common Terminal 8 (If used) is 125 Vrms; and 250 Vrms with respect to AC Power (meter Terminals 1 & 2). To be certain that the ratings are not exceeded, these voltages should be verified by a high-voltage meter before wiring the meter.

CAUTION:

1. Where possible, connect the neutral side of the signal (including current shunts) to the input common of the meter. If the input signal is sourced from an active circuit, connect the lower impedance (usually circuit common) to the input signal common of the meter.

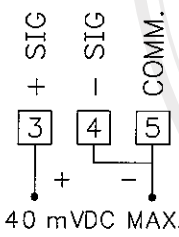
2. For phase-to-phase line monitoring where a neutral does not exist, or for any other signal input in which the isolation voltage rating is exceeded, an isolating potential transformer must be used to isolate the input voltage from earth. With the transformer, the input common of the meter can then be earth referenced for safety.

3. When measuring line currents, the use of a current transformer is recommended. If using external current shunts, insert the shunt in the neutral return line. If the isolation voltage rating is exceeded, the use of an isolating current transformer is necessary.

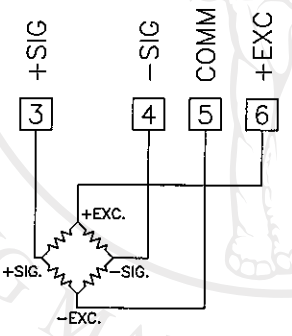
PAXS INPUT SIGNAL WIRING

Before connecting signal wires, the Input Range Jumper should be verified for proper position.

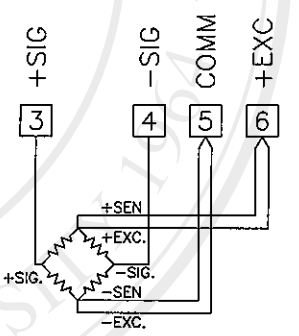
2-Wire Single Ended Input



4-Wire Bridge Input



6-Wire Bridge Input



DEADLOAD COMPENSATION

In some cases, the combined deadload and liveload output may exceed the range of the 24 mV input. To use this range, the output of the bridge can be offset a small amount by applying a fixed resistor across one arm of the bridge. This shifts the electrical output of the bridge downward to within the operating range of the meter. A 100 K ohm fixed resistor shifts the bridge output approximately -10 mV (350 ohm bridge, 10 V excitation).

Connect the resistor between +SIG and -SIG. Use a metal film resistor with a low temperature coefficient of resistance.

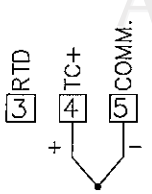
BRIDGE COMPLETION RESISTORS

For single strain gage applications, bridge completion resistors must be employed externally to the meter. Only use metal film resistors with a low temperature coefficient of resistance.

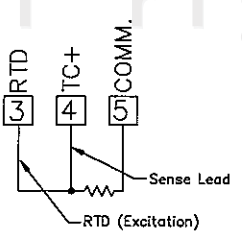
Load cells and pressure transducers are normally implemented as full resistance bridges and do not require bridge completion resistors.

PAXT INPUT SIGNAL WIRING

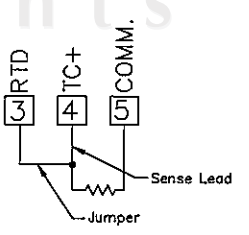
Thermocouple



3-Wire RTD



2-Wire RTD



CAUTION: Sensor input common is NOT isolated from user input common. In order to preserve the safety of the meter application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.

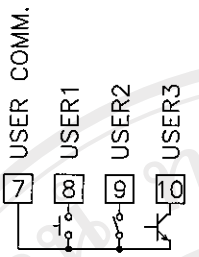
3.3 USER INPUT WIRING

Before connecting the wires, the User Input Logic Jumper should be verified for proper position. If not using User Inputs, then skip this section. Only the appropriate User Input terminal has to be wired.

Sinking Logic

Terminal 8-10: } Connect external switching device between
Terminal 7: } appropriate User Input terminal and User Comm.

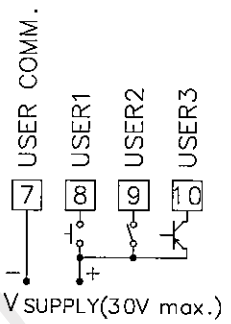
In this logic, the user inputs of the meter are internally pulled up to +5 V with 22 K resistance. The input is active when it is pulled low (<0 .9 V).



Sourcing Logic

Terminal 8-10: + VDC thru external switching device
Terminal 7: -VDC thru external switching device

In this logic, the user inputs of the meter are internally pulled down to 0 V with 22 K resistance. The input is active when a voltage greater than 3.6 VDC is applied.

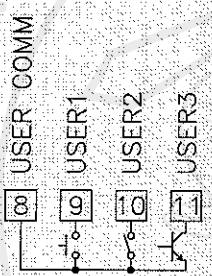


PAXH ONLY

Sinking Logic

Terminals 9-11 } Connect external
Terminal 8 } switching device between appropriate User Input terminal and User Comm.

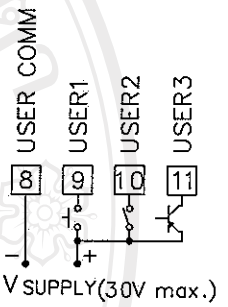
In this logic, the user inputs of the meter are internally pulled up to +5 V with 22 K resistance. The input is active when it is pulled low (<0 .9 V).



Sourcing Logic

Terminals 9-11:
+ VDC through external switching device
Terminal 8:
-VDC through external switching device

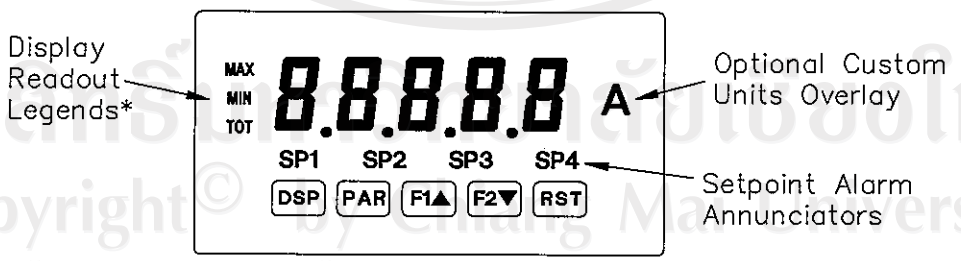
In this logic, the user inputs of the meter are internally pulled down with 22 K resistance. The input is active when a voltage greater than 3.6 VDC is applied.



3.4 SETPOINT (ALARMS) WIRING
3.5 SERIAL COMMUNICATION WIRING
3.6 ANALOG OUTPUT WIRING

} ***See appropriate plug-in card bulletin for details.***

4.0 REVIEWING THE FRONT BUTTONS AND DISPLAY



KEY	DISPLAY MODE OPERATION	PROGRAMMING MODE OPERATION
DSP	Index display through max/min/total/input readouts	Quit programming and return to display mode
PAR	Access parameter list	Store selected parameter and index to next parameter
F1▲	Function key 1; hold for 3 seconds for Second Function 1**	Increment selected parameter value
F2▼	Function key 2; hold for 3 seconds for Second Function 2**	Decrement selected parameter value
RST	Reset (Function key)**	Hold with F1▲, F2▼ to scroll value by x1000

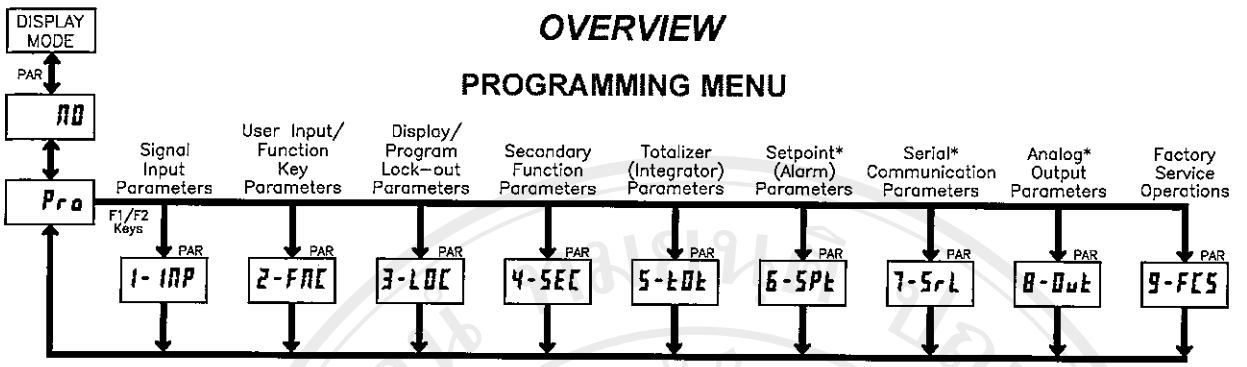
* Display Readout Legends may be locked out in Factory Settings.

** Factory setting for the F1, F2, and RST keys is NO mode.

5.0 PROGRAMMING THE METER

OVERVIEW

PROGRAMMING MENU



* Only accessible with appropriate plug-in card.

DISPLAY MODE

The meter normally operates in the Display Mode. In this mode, the meter displays can be viewed consecutively by pressing the **DSP** key. The annunciators to the left of the display indicate which display is currently shown; Max Value (MAX), Min Value (MIN), or Totalizer Value (TOT). Each of these displays can be locked from view through programming. (See Module 3) The Input Display Value is shown with no annunciator.

PROGRAMMING MODE

Two programming modes are available.

Full Programming Mode permits all parameters to be viewed and modified. Upon entering this mode, the front panel keys change to Programming Mode operations. This mode should not be entered while a process is running, since the meter functions and User Input response may not operate properly while in Full Programming Mode.

Quick Programming Mode permits only certain parameters to be viewed and/or modified. When entering this mode, the front panel keys change to Programming Mode operations, and all meter functions continue to operate properly. Quick Programming Mode is configured in Module 3. The Display Intensity Level "d-LEv" parameter is available in the Quick Programming Mode only when the security code is non-zero. For a description, see Module 9—Factory Service Operations. Throughout this document, Programming Mode (without Quick in front) always refers to "Full" Programming Mode.

PROGRAMMING TIPS

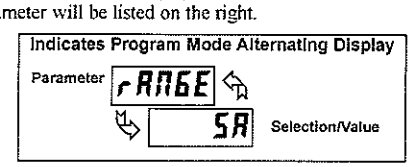
The Programming Menu is organized into nine modules (See above). These modules group together parameters that are related in function. It is recommended to begin programming with Module 1 and proceed through each module in sequence. Note that Modules 6 through 8 are only accessible when the appropriate plug-in option card is installed. If lost or confused while programming, press the **DSP** key to exit programming mode and start over. When programming is complete, it is recommended to record the meter settings on the Parameter Value Chart and lock-out parameter programming with a User Input or lock-out code. (See Modules 2 and 3 for lock-out details.)

FACTORY SETTINGS

Factory Settings may be completely restored in Module 9. This is a good starting point if encountering programming problems. Throughout the module description sections which follow, the factory setting for each parameter is shown below the parameter display. In addition, all factory settings are listed on the Parameter Value Chart following the programming section.

ALTERNATING SELECTION DISPLAY

In the module description sections which follow, the dual display with arrows appears for each programming parameter. This is used to illustrate the display alternating between the parameter (top display) and the parameter's Factory Setting (bottom display). In most cases, selections or value ranges for the parameter will be listed on the right.



STEP BY STEP PROGRAMMING INSTRUCTIONS:

PROGRAMMING MODE ENTRY (PAR KEY)

The Programming Mode is entered by pressing the **PAR** key. If this mode is not accessible, then meter programming is locked by either a security code or a hardware lock. (See Modules 2 and 3 for programming lock-out details.)

MODULE ENTRY (ARROW & PAR KEYS)

Upon entering the Programming Mode, the display alternates between Pro and the present module (initially no). The arrow keys (**F1▲** and **F2▼**) are used to select the desired module, which is then entered by pressing the **PAR** key.

PARAMETER (MODULE) MENU (PAR KEY)

Each module has a separate parameter menu. These menus are shown at the start of each module description section which follows. The **PAR** key is pressed to advance to a particular parameter to be changed, without changing the programming of preceding parameters. After completing a module, the display will return to Pro no. From this point, programming may continue by selecting and entering additional modules. (See **MODULE ENTRY** above.)

PARAMETER SELECTION ENTRY (ARROW & PAR KEYS)

For each parameter, the display alternates between the parameter and the present selection or value for that parameter. For parameters which have a list of selections, the arrow keys (**F1▲** and **F2▼**) are used to sequence through the list until the desired selection is displayed. Pressing the **PAR** key stores and activates the displayed selection, and also advances the meter to the next parameter.

NUMERICAL VALUE ENTRY (ARROW, RST & PAR KEYS)

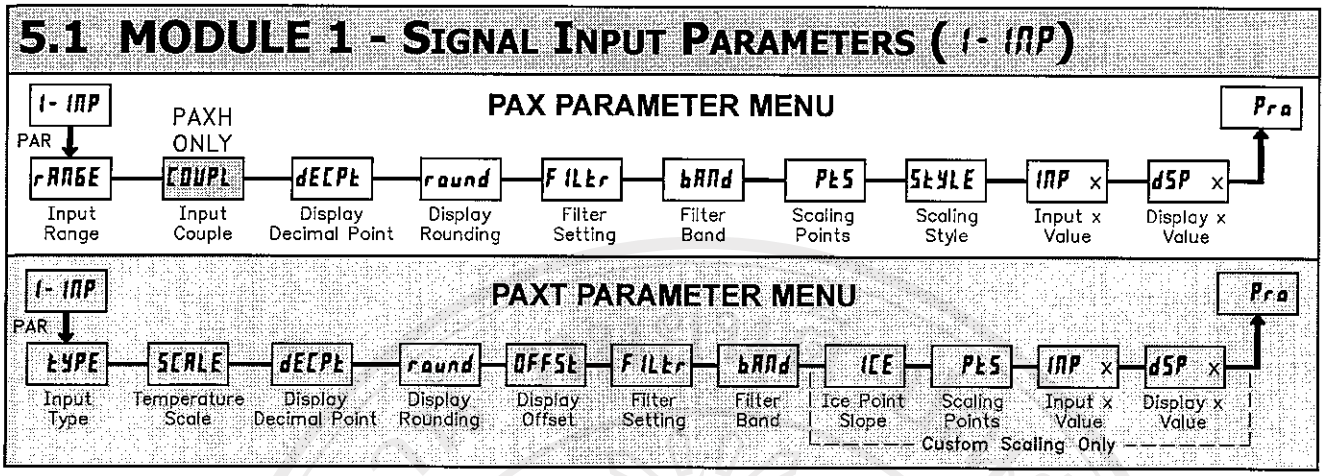
For parameters which require a numerical value entry, the arrow keys can be used to increment or decrement the display to the desired value. When an arrow key is pressed and held, the display automatically scrolls up or scrolls down. The longer the key is held, the faster the display scrolls.

The **RST** key can be used in combination with the arrow keys to enter large numerical values. When the **RST** key is pressed along with an arrow key, the display scrolls by 1000's. Pressing the **PAR** key stores and activates the displayed value, and also advances the meter to the next parameter.

PROGRAMMING MODE EXIT (DSP KEY or PAR KEY at Pro no)

The Programming Mode is exited by pressing the **DSP** key (from anywhere in the Programming Mode) or the **PAR** key (with Pro no displayed). This will commit any stored parameter changes to memory and return the meter to the Display Mode. If a parameter was just changed, the **PAR** key should be pressed to store the change before pressing the **DSP** key. (If power loss occurs before returning to the Display Mode, verify recent parameter changes.)

5.1 MODULE 1 - SIGNAL INPUT PARAMETERS (1- INP)



Refer to the appropriate Input Range for the selected meter. Use only one Input Range, then proceed to Display Decimal Point.

PAXD INPUT RANGE

rANGE
300u

SELECTION	RANGE RESOLUTION	SELECTION	RANGE RESOLUTION
200uA	±200.00 µA	2u	±2.0000 V
0.002A	±2.0000 mA	20u	±20.000 V
0.02A	±20.000 mA	300u	±300.00 V
0.2A	±200.00 mA	100o	100.00 ohm
2A	±2.0000 A	1000o	1000.0 ohm
0.2u	±200.00 mV	10Ko	10000 ohm

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXP INPUT RANGE

rANGE
0.02A

SELECTION	RANGE RESOLUTION
0.02A	20.000 mA
10u	10.000 V

Select the input range that corresponds to the external signal.

PAXH INPUT RANGE

rANGE
5A

SELECTION	RANGE RESOLUTION	SELECTION	RANGE RESOLUTION
0.2u	200.00 mV	0.002A	2.0000 mA
2u	2.0000 V	0.02A	20.000 mA
20u	20.000 V	0.2A	200.00 mA
300u	300.0 V	5A	5.000 A
200uA	200.00 µA		

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXH INPUT COUPLE

COUPL
AC

AC or dC

The input signal can be either AC coupled (rejecting the DC components of the signal) or DC coupled (measures both the AC and DC components of the signal). The coupling jumper and the setting of this parameter must match.

PAXS INPUT RANGE

rANGE
0.02u

SELECTION	RANGE RESOLUTION
0.02u	±24 mV
0.2u	±240 mV

Select the input range that corresponds to the external signal. This selection should be high enough to avoid input signal overload but low enough for the desired input resolution. This selection and the position of the Input Range Jumper must match.

PAXT INPUT TYPE

tYPE
tc-J

SELECTION	TYPE	SELECTION	TYPE
tc-t	T TC	tc-c	C TC
tc-E	E TC	Pt385	RTD platinum 385
tc-J	J TC	Pt392	RTD platinum 392
tc-K	K TC	n.672	RTD nickel 672
tc-r	R TC	Cu427	RTD copper 10 Ω
tc-S	S TC	CS-tc	Custom TC
tc-b	B TC	CS-rH	Custom RTD High
tc-n	N TC	CS-rL	Custom RTD Low

Select the input type that corresponds to the input sensor. For RTD types, check the RTD Input Jumper for matching selection. For custom types, the Temperature Scale parameter is not available, the Display Decimal Point is expanded, and Custom Sensor Scaling must be completed.

PAXT TEMPERATURE SCALE

SCALE
oF

oF oC

Select the temperature scale. This selection applies for Input, MAX, MIN, and TOT displays. This does not change the user installed Custom Units Overlay display. If changed, those parameters that relate to the temperature scale should be checked. This selection is not available for custom sensor types.

DISPLAY DECIMAL POINT

dECPt
0

0 0.0 0.00 0.000 0.0000

For the PAXT, these are only available with Custom Scaling.

Select the decimal point location for the Input, **MAX** and **MIN** displays. (The **TOT** display decimal point is a separate parameter.) This selection also affects *round*, *dSP1* and *dSP2* parameters and setpoint values.

DISPLAY ROUNDING*

round → 1

1 2 5 10 20 50 100

These bottom selections are not available for the PAXT.

Rounding selections other than one, cause the Input Display to 'round' to the nearest rounding increment selected (ie. rounding of '5' causes 122 to round to 120 and 123 to round to 125). Rounding starts at the least significant digit of the Input Display. Remaining parameter entries (scaling point values, setpoint values, etc.) are not automatically adjusted to this display rounding selection.

PAXT: TEMPERATURE DISPLAY OFFSET*

OFFSE → 0 — -19999 to 99999

The temperature display can be corrected with an offset value. This can be used to compensate for probe errors, errors due to variances in probe placement or adjusting the readout to a reference thermometer. This value is automatically updated after a Zero Display to show how far the display is offset. A value of zero will remove the affects of offset.

FILTER SETTING*

FILtr → 1.0 — 0.0 to 25.0 seconds

The input filter setting is a time constant expressed in tenths of a second. The filter settles to 99% of the final display value within approximately 3 time constants. This is an Adaptive Digital Filter which is designed to steady the Input Display reading. A value of '0' disables filtering.

FILTER BAND*

bAnd → 10 — 0.0 to 25.0 display units

The digital filter will adapt to variations in the input signal. When the variation exceeds the input filter band value, the digital filter disengages. When the variation becomes less than the band value, the filter engages again. This allows for a stable readout, but permits the display to settle rapidly after a large process change. The value of the band is in display units. A band setting of '0' keeps the digital filter permanently engaged.

For the PAXT, the following parameters only apply to Custom Sensor Scaling.

PAXT: ICE POINT SLOPE

ICE → 0.00 — 0 to 65.000 µV/°C

This parameter sets the slope value for ice point compensation for the Custom TC range (CS-tc) only. The fixed thermocouple ranges are automatically compensated by the meter and do not require this setting. To calculate this slope, use µV data obtained from thermocouple manufacturers' tables for two points between 0°C and 50°C. Place this corresponding µV and °C information into the equation:

slope = $(\mu V_2 - \mu V_1)/(°C_2 - °C_1)$.

Due to the nonlinear output of thermocouples, the compensation may show a small offset error at room temperatures. This can be compensated by the offset parameter. A value of 0 disables internal compensation when the thermocouple is externally compensated.

* *Factory Setting can be used without affecting basic start-up.*

SCALING POINTS*

PtS → 2 — 2 to 16

Linear - Scaling Points (2)

For linear processes, only 2 scaling points are necessary. It is recommended that the 2 scaling points be at opposite ends of the input signal being applied. The points do not have to be the signal limits. Display scaling will be linear between and continue past the entered points up to the limits of the Input Signal Jumper position. Each scaling point has a coordinate-pair of Input Value (*InP*) and an associated desired Display Value (*dSP*).

Nonlinear - Scaling Points (Greater than 2)

For non-linear processes, up to 16 scaling points may be used to provide a piece-wise linear approximation. (The greater the number of scaling points used, the greater the conformity accuracy.) The Input Display will be linear between scaling points that are sequential in program order. Each scaling point has a coordinate-pair of Input Value (*InP*) and an associated desired Display Value (*dSP*). Data from tables or equations, or empirical data could be used to derive the required number of segments and data values for the coordinate pairs. In the SFPAX software, several linearization equations are available.

SCALING STYLE

This parameter does not apply for the PAXT. Scaling values for the PAXT must be keyed-in.

StYLE → KEY — KEY key-in data; APLY apply signal

If Input Values and corresponding Display Values are known, the Key-in (*KEY*) scaling style can be used. This allows scaling without the presence or changing of the input signal. If Input Values have to be derived from the actual input signal source or simulator, the Apply (*APLY*) scaling style must be used. After using the Apply (*APLY*) scaling style, this parameter will default back to *KEY* but the scaling values will be shown from the previous applied method.

INPUT VALUE FOR SCALING POINT 1

InP 1 → 0.00 — -19999 to 99999

For Key-in (*KEY*), enter the known first Input Value by using the arrow keys. (The Input Range selection sets up the decimal location for the Input Value). For Apply (*APLY*), apply the input signal to the meter, adjust the signal source externally until the desired Input Value appears. In either method, press the **PAR** key to enter the value being displayed.

Note: APLY style - Pressing the **RST** *key will advance the display to the next scaling display point without storing the input value.*

DISPLAY VALUE FOR SCALING POINT 1

dSP 1 → 0.00 — -19999 to 99999

Enter the first coordinating Display Value by using the arrow keys. This is the same for *KEY* and *APLY* scaling styles. The decimal point follows the *dECPt* selection.

INPUT VALUE FOR SCALING POINT 2

InP 2 → 100.00 — -19999 to 99999

For Key-in (*KEY*), enter the known second Input Value by using the arrow keys. For Apply (*APLY*), adjust the signal source externally until the next desired Input Value appears. (Follow the same procedure if using more than 2 scaling points.)

DISPLAY VALUE FOR SCALING POINT 2

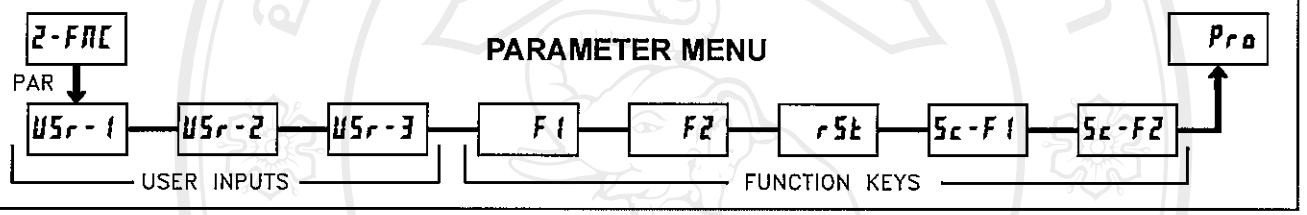
- 19999 to 99999

Enter the second coordinating Display Value by using the arrow keys. This is the same for KEY and APLY scaling styles. (Follow the same procedure if using more than 2 scaling points.)

General Notes on Scaling

1. Input Values for scaling points should be confined to the limits of the Input Range Jumper position.
2. The same Input Value should not correspond to more than one Display Value. (Example: 20 mA can not equal 0 and 10.)
   This is referred to as read out jumps (vertical scaled segments).
3. The same Display Value can correspond to more than one Input Value. (Example: 0 mA and 20 mA can equal 10.)
   This is referred to as readout dead zones (horizontal scaled segments).
4. The maximum scaled Display Value spread between range maximum and minimum is limited to 65,535. For example using +20 mA range the maximum +20 mA can be scaled to is 32,767 with 0 mA being 0 and Display Rounding of 1. (Decimal points are ignored.) The other half of 65,535 is for the lower half of the range 0 to -20 mA even if it is not used. With Display Rounding of 2, +20 mA can be scaled for 65,535 (32,767 x 2) but with even Input Display values shown.
5. For input levels beyond the first programmed Input Value, the meter extends the Display Value by calculating the slope from the first two coordinate pairs (INP 1 / dSP 1 & INP2 / dSP2). If INP 1 = 4 mA and dSP 1 = 0, then 0 mA would be some negative Display Value. This could be prevented by making INP 1 = 0 mA / dSP 1 = 0, INP2 = 4 mA / dSP2 = 0, with INP3 = 20 mA / dSP3 = the desired high Display Value. The calculations stop at the limits of the Input Range Jumper position.
6. For input levels beyond the last programmed Input Value, the meter extends the Display Value by calculating the slope from the last two sequential coordinate pairs. If three coordinate pair scaling points were entered, then the Display Value calculation would be between INP2 / dSP2 & INP3 / dSP3. The calculations stop at the limits of the Input Range Jumper position.

5.2 MODULE 2 - USER INPUT AND FRONT PANEL FUNCTION KEY PARAMETERS (2-FNC)



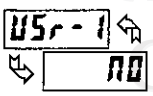
The three user inputs are individually programmable to perform specific meter control functions. While in the Display Mode or Program Mode, the function is executed the instant the user input transitions to the active state.

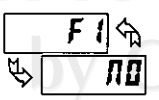
The front panel function keys are also individually programmable to perform specific meter control functions. While in the Display Mode, the primary function is executed the instant the key is pressed. Holding the function key for three seconds executes a secondary function. It is possible to program a secondary function without a primary function.

In most cases, if more than one user input and/or function key is programmed for the same function, the maintained (level trigger) actions will be performed while at least one of those user inputs or function keys are activated. The momentary (edge trigger) actions will be performed every time any of those user inputs or function keys transition to the active state.

Note: In the following explanations, not all selections are available for both user inputs and front panel function keys. Alternating displays are shown with each selection. Those selections showing both displays are available for both. If a display is not shown, it is not available for that selection. USr-1 *will represent all three user inputs.* F1 *will represent all five function keys.*

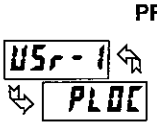
NO FUNCTION





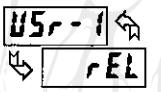
No function is performed if activated. This is the factory setting for all user inputs and function keys. No function can be selected without affecting basic start-up.

PROGRAMMING MODE LOCK-OUT



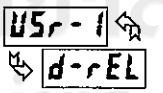
Programming Mode is locked-out, as long as activated (maintained action). A security code can be configured to allow programming access during lock-out.

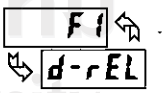
ZERO (TARE) DISPLAY



The Zero (Tare) Display provides a way to zero the Input Display value at various input levels, causing future Display readings to be offset. This function is useful in weighing applications where the container or material on the scale should not be included in the next measurement value. When activated (momentary action), rESEt flashes and the Display is set to zero. At the same time, the Display value (that was on the display before the Zero Display) is subtracted from the Display Offset Value and is automatically stored as the new Display Offset Value (OFFSt). If another Zero (tare) Display is performed, the display will again change to zero and the Display reading will shift accordingly.

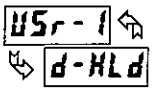
RELATIVE/ABSOLUTE DISPLAY





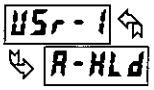
This function will switch the Input Display between Relative and Absolute. The Relative is a net value that includes the Display Offset Value. The Input Display will normally show the Relative unless switched by this function. Regardless of the display selected, all meter functions continue to operate based on relative values. The Absolute is a gross value (based on Module 1 **DSP** and **INP** entries) without the Display Offset Value. The Absolute display is selected as long as the user input is activated (maintained action) or at the transition of the function key (momentary action). When the user input is released, or the function key is pressed again, the input display switches back to Relative display. AbS (absolute) or rEL (relative) is momentarily displayed at transition to indicate which display is active.

HOLD DISPLAY



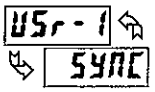
The shown display is held but all other meter functions continue as long as activated (maintained action).

HOLD ALL FUNCTIONS



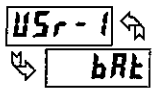
The meter disables processing the input, holds all display contents, and locks the state of all outputs as long as activated (maintained action). The serial port continues data transfer.

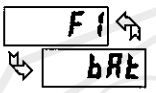
SYNCHRONIZE METER READING



The meter suspends all functions as long as activated (maintained action). When the user input is released, the meter synchronizes the restart of the A/D with other processes or timing events.

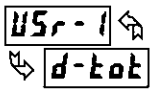
STORE BATCH READING IN TOTALIZER





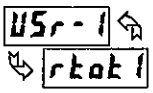
The Input Display value is one time added (batched) to the Totalizer at transition to activate (momentary action). The Totalizer retains a running sum of each batch operation until the Totalizer is reset. When this function is selected, the normal operation of the Totalizer is overridden.

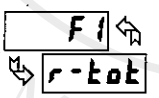
SELECT TOTALIZER DISPLAY



The Totalizer display is selected as long as activated (maintained action). When the user input is released, the Input Display is returned. The **DSP** key overrides the active user input. The Totalizer continues to function including associated outputs independent of being displayed.

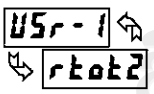
RESET TOTALIZER





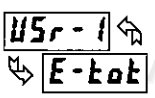
When activated (momentary action), rESEt flashes and the Totalizer resets to zero. The Totalizer then continues to operate as it is configured. This selection functions independent of the selected display.

RESET AND ENABLE TOTALIZER



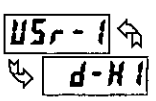
When activated (momentary action), rESEt flashes and the Totalizer resets to zero. The Totalizer continues to operate while active (maintained action). When the user input is released, the Totalizer stops and holds its value. This selection functions independent of the selected display.

ENABLE TOTALIZER



The Totalizer continues to operate as long as activated (maintained action). When the user input is released, the Totalizer stops and holds its value. This selection functions independent of the selected display.

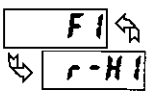
SELECT MAXIMUM DISPLAY



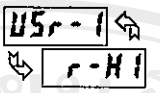
The Maximum display is selected as long as activated (maintained action). When the user input is released, the Input Display returns. The **DSP** key overrides the active user input. The Maximum continues to function independent of being displayed.

RESET MAXIMUM

When activated (momentary action), rESEt flashes and the Maximum resets to the present Input Display value. The Maximum function then continues from that value. This selection functions independent of the selected display.

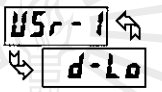


RESET, SELECT, ENABLE MAXIMUM DISPLAY



When activated (momentary action), the Maximum value is set to the present Input Display value. Maximum continues from that value while active (maintained action). When the user input is released, Maximum detection stops and holds its value. This selection functions independent of the selected display. The **DSP** key overrides the active user input display but not the Maximum function.

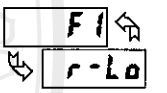
SELECT MINIMUM DISPLAY



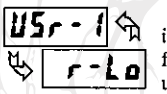
The Minimum display is selected as long as activated (maintained action). When the user input is released, the Input Display is returned. The **DSP** key overrides the active user input. The Minimum continues to function independent of being displayed.

RESET MINIMUM

When activated (momentary action), rESEt flashes and the Minimum reading is set to the present Input Display value. The Minimum function then continues from that value. This selection functions independent of the selected display.

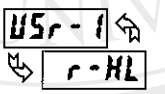


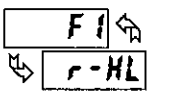
RESET, SELECT, ENABLE MINIMUM DISPLAY



When activated (momentary action), the Minimum value is set to the present Input Display value. Minimum continues from that value while active (maintained action). When the user input is released, Minimum detection stops and holds its value. This selection functions independent of the selected display. The **DSP** key overrides the active user input display but not the Minimum function.

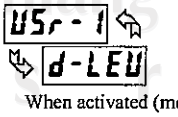
RESET MAXIMUM AND MINIMUM

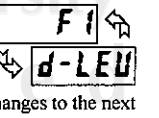




When activated (momentary action), rESEt flashes and the Maximum and Minimum readings are set to the present Input Display value. The Maximum and Minimum function then continues from that value. This selection functions independent of the selected display.

CHANGE DISPLAY INTENSITY LEVEL





When activated (momentary action), the display intensity changes to the next intensity level (of 4). The four levels correspond to Display Intensity Level (d-LEu) settings of 0, 3, 8, and 15. The intensity level, when changed via the User Input/ Function Key, is not retained at power-down, unless Quick Programming or Full Programming mode is entered and exited. The meter will power-up at the last saved intensity level.

SETPOINT SELECTIONS

The following selections are accessible only with the Setpoint plug-in card installed. Refer to the Setpoint Card Bulletin shipped with the Setpoint plug-in card for an explanation of their operation.

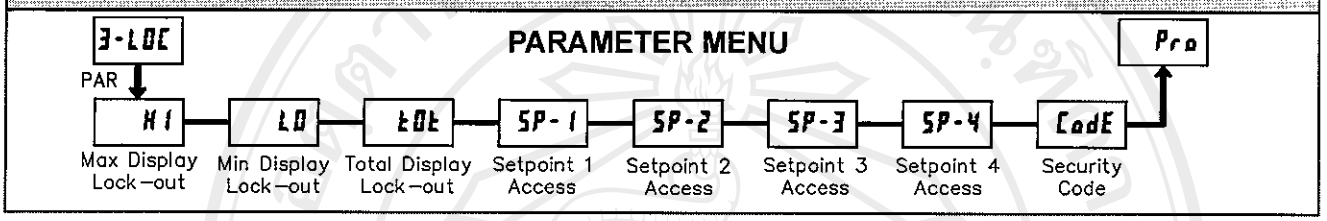
Setpoint Card Only

- **LISt - Select main or alternate setpoints**
- **r-1 - Reset Setpoint 1 (Alarm 1)**
- **r-2 - Reset Setpoint 2 (Alarm 2)**
- **r-3 - Reset Setpoint 3 (Alarm 3)**
- **r-4 - Reset Setpoint 4 (Alarm 4)**
- **r-34 - Reset Setpoint 3 & 4 (Alarm 3 & 4)**
- **r-234 - Reset Setpoint 2, 3 & 4 (Alarm 2, 3 & 4)**
- **r-ALL - Reset Setpoint All (Alarm All)**

PRINT REQUEST

The meter issues a block print through the serial port when activated. The data transmitted during a print request is programmed in Module 7. If the user input is still active after the transmission is complete (about 100 msec), an additional transmission occurs. As long as the user input is held active, continuous transmissions occur.

5.3 MODULE 3 - DISPLAY AND PROGRAM LOCK-OUT PARAMETERS (3-LOC)



Module 3 is the programming for Display lock-out and "Full" and "Quick" Program lock-out.

When in the Display Mode, the available displays can be read consecutively by repeatedly pressing the **DSP** key. An annunciator indicates the display being shown. These displays can be locked from being visible. It is recommended that the display be set to LOC when the corresponding function is not used.

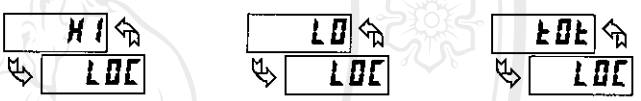
SELECTION	DESCRIPTION
rEd	Visible in Display Mode
LOC	Not visible in Display Mode

"Full" Programming Mode permits all parameters to be viewed and modified. This Programming Mode can be locked with a security code and/or user input. When locked and the **PAR** key is pressed, the meter enters a Quick Programming Mode. In this mode, the setpoint values can still be read and/or changed per the selections below. The Display Intensity Level (d-LEU) parameter also appears whenever Quick Programming Mode is enabled and the security code is greater than zero.

SELECTION	DESCRIPTION
rEd	Visible but not changeable in Quick Programming Mode
EntE	Visible and changeable in Quick Programming Mode
LOC	Not visible in Quick Programming Mode

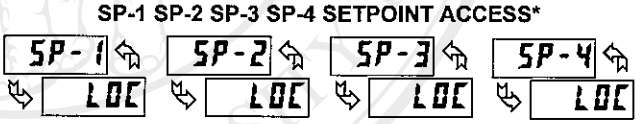
* *Factory Setting can be used without affecting basic start-up.*

MAXIMUM DISPLAY LOCK-OUT*
MINIMUM DISPLAY LOCK-OUT*
TOTALIZER DISPLAY LOCK-OUT*



These displays can be programmed for LOC or rEd. When programmed for LOC, the display will not be shown when the **DSP** key is pressed regardless of Program Lock-out status. It is suggested to lock-out the display if it is not needed. The associated function will continue to operate even if its display is locked-out.

SP-1 SP-2 SP-3 SP-4 SETPOINT ACCESS*



The setpoint displays can be programmed for LOC, rEd or EntE (See the following table). Accessible only with the Setpoint plug-in card installed.

PROGRAM MODE SECURITY CODE*

By entering any non-zero value, the prompt CodE 0 will appear when trying to access the Program Mode. Access will only be allowed after entering a matching security code or universal code of 222. With this lock-out, a user input would not have to be configured for Program Lock-out. However, this lock-out is overridden by an inactive user input configured for Program Lock-out.

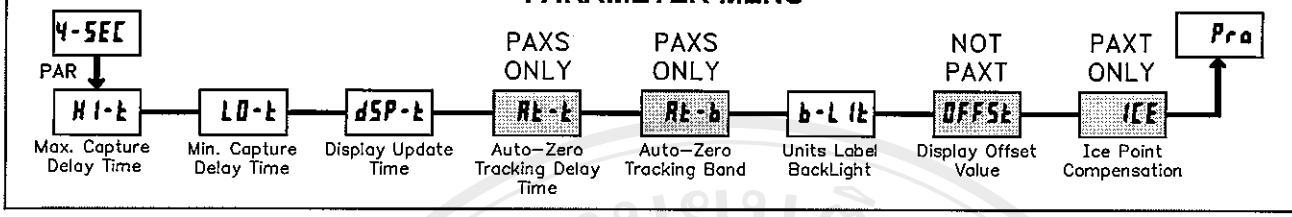
PROGRAMMING MODE ACCESS

SECURITY CODE	USER INPUT CONFIGURED	USER INPUT STATE	WHEN PAR KEY IS PRESSED	"FULL" PROGRAMMING MODE ACCESS
0	not PLOC	———	"Full" Programming	Immediate access.
>0	not PLOC	———	Quick Programming w/Display Intensity	After Quick Programming with correct code # at CodE prompt.
>0	PLOC	Active	Quick Programming w/Display Intensity	After Quick Programming with correct code # at CodE prompt.
>0	PLOC	Not Active	"Full" Programming	Immediate access.
0	PLOC	Active	Quick Programming	No access
0	PLOC	Not Active	"Full" Programming	Immediate access.

Throughout this document, Programming Mode (without Quick in front) always refers to "Full" Programming (all meter parameters are accessible).

5.4 MODULE 4 - SECONDARY FUNCTION PARAMETERS (4-SEC)

PARAMETER MENU



MAX CAPTURE DELAY TIME*

H1-t
0.0

0.0 to 3275.0 sec.

When the Input Display is above the present MAX value for the entered delay time, the meter will capture that display value as the new MAX reading. A delay time helps to avoid false captures of sudden short spikes.

MIN CAPTURE DELAY TIME*

LO-t
0.0

0.0 to 3275.0 sec.

When the Input Display is below the present MIN value for the entered delay time, the meter will capture that display value as the new MIN reading. A delay time helps to avoid false captures of sudden short spikes.

DISPLAY UPDATE RATE*

dSP-t
2

1 2 5 10 20 updates/sec.

This parameter determines the rate of display update. When set to 20 updates/second, the internal re-zero compensation is disabled, allowing for the fastest possible output response.

PAXS: AUTO-ZERO TRACKING

Rt-t
0

0 to 250 sec.

PAXS: AUTO-ZERO BAND

Rt-b
0.02

1 to 4095

The meter can be programmed to automatically compensate for zero drift. Drift may be caused by changes in the transducers or electronics, or accumulation of material on weight systems.

Auto-zero tracking operates when the readout remains within the tracking band for a period of time equal to the tracking delay time. When these conditions are met, the meter re-zeroes the readout. After the re-zero operation, the meter resets and continues to auto-zero track.

The auto-zero tracking band should be set large enough to track normal zero drift, but small enough to not interfere with small process inputs.

For filling operations, the fill rate must exceed the auto-zero tracking rate. This avoids false tracking at the start of the filling operation.

$$\text{Fill Rate} \geq \frac{\text{tracking band}}{\text{tracking time}}$$

Auto-zero tracking is disabled by setting the auto-zero tracking parameter = 0.

UNITS LABEL BACKLIGHT*

b-L It
OFF

ON OFF

The Units Label Kit Accessory contains a sheet of custom unit overlays which can be installed in to the meter's bezel display assembly. The backlight for these custom units is activated by this parameter.

DISPLAY OFFSET VALUE*

This parameter does not apply for the PAXT.

OFFSt
0.00

-19999 to 19999

Unless a Zero Display was performed or an offset from Module 1 scaling is desired, this parameter can be skipped. The Display Offset Value is the difference from the Absolute (gross) Display value to the Relative (net) Display value for the same input level. The meter will automatically update this Display Offset Value after each Zero Display. The Display Offset Value can be directly keyed-in to intentionally add or remove display offset. See Relative / Absolute Display and Zero Display explanations in Module 2.

PAXT: ICE POINT COMPENSATION*

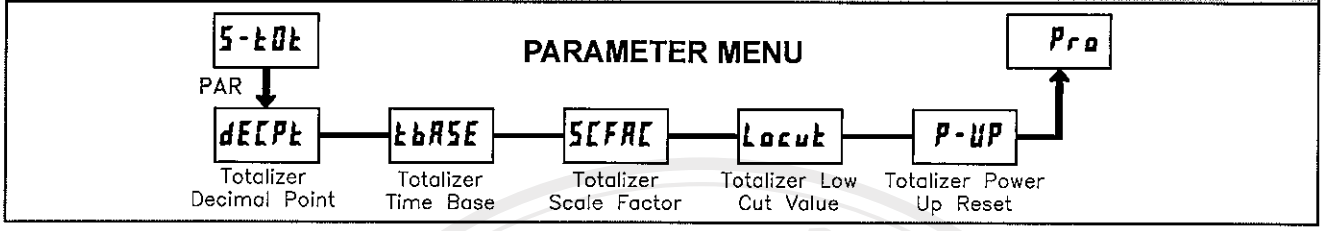
ICE
ON

ON OFF

This parameter turns the internal ice point compensation on or off. Normally, the ice point compensation is on. If using external compensation, set this parameter to off. In this case, use copper leads from the external compensation point to the meter. If using Custom TC range, the ice point compensation can be adjusted by a value in Module 1 when this is yes.

* *Factory Setting can be used without affecting basic start-up.*

5.5 MODULE 5 - TOTALIZER (INTEGRATOR) PARAMETERS (5-tOt)



The totalizer accumulates (integrates) the Input Display value using one of two modes. The first is using a time base. This can be used to compute a time-temperature product. The second is through a user input or function key programmed for Batch (one time add on demand). This can be used to provide a readout of temperature integration, useful in curing and sterilization applications. If the Totalizer is not needed, its display can be locked-out and this module can be skipped during programming.

TOTALIZER DECIMAL POINT*

dECPt → 0.00

0 0.0 0.00 0.000 0.0000

For most applications, this matches the Input Display Decimal Point (*dECPt*). If a different location is desired, refer to Totalizer Scale Factor.

TOTALIZER TIME BASE

tbASE → .1M

SEC - seconds (÷ 1) hour - hours (÷ 3600)
.1M - minutes (÷ 60) dAY - days (÷ 86400)

This is the time base used in Totalizer accumulations. If the Totalizer is being accumulated through a user input programmed for Batch, then this parameter does not apply.

TOTALIZER SCALE FACTOR*

SCFAC → 1.000

0.001 to 65.000

For most applications, the Totalizer reflects the same decimal point location and engineering units as the Input Display. In these cases, the Totalizer Scale Factor is 1.000. The Totalizer Scale Factor can be used to scale the Totalizer to a different value than the Input Display. Common possibilities are:

1. Changing decimal point location (example tenths to whole)
2. Average over a controlled time frame.

Details on calculating the scale factor are shown later.

If the Totalizer is being accumulated through a user input programmed for Batch, then this parameter does not apply.

TOTALIZER LOW CUT VALUE*

Locut → -19999

-19999 to 99999

A low cut value disables Totalizer when the Input Display value falls below the value programmed.

TOTALIZER POWER UP RESET*

P-UP → nO

nO Do not reset buffer
rSt Reset buffer

The Totalizer can be reset to zero on each meter power-up by setting this parameter to reset.

* *Factory Setting can be used without affecting basic start-up.*

TOTALIZER HIGH ORDER DISPLAY

When the total exceeds 5 digits, the front panel annunciator **TOT** flashes. In this case, the meter continues to totalize up to a 9 digit value. The high order 4 digits and the low order 5 digits of the total are displayed alternately. The letter "h" denotes the high order display.

TOTALIZER BATCHING

The Totalizer Time Base and scale factor are overridden when a user input or function key is programmed for store batch (*bAt*). In this mode, when the user input or function key is activated, the Input Display reading is one time added to the Totalizer (batch). The Totalizer retains a running sum of each batch operation until the Totalizer is reset. This is useful in weighing operations, when the value to be added is not based on time but after a filling event.

TOTALIZER USING TIME BASE

Totalizer accumulates as defined by:

$$\frac{\text{Input Display} \times \text{Totalizer Scale Factor}}{\text{Totalizer Time Base}}$$

Where:
Input Display - the present input reading
Totalizer Scale Factor - 0.001 to 65.000
Totalizer Time Base - (the division factor of *tbASE*)

Example: The input reading is at a constant rate of 10.0 gallons per minute. The Totalizer is used to determine how many gallons in tenths has flowed. Because the Input Display and Totalizer are both in tenths of gallons, the Totalizer Scale Factor is 1. With gallons per minute, the Totalizer Time Base is minutes (60). By placing these values in the equation, the Totalizer will accumulate every second as follows:

$\frac{10.0 \times 1.000}{60} = 0.1667$ gallon accumulates each second

This results in:
10.0 gallons accumulates each minute
600.0 gallons accumulates each hour

TOTALIZER SCALE FACTOR CALCULATION EXAMPLES

1. When changing the Totalizer Decimal Point (*dECPt*) location from the Input Display Decimal Point (*dECPt*), the required Totalizer Scale Factor is multiplied by a power of ten.

Example: Input (*dECPt*) = 0.0 Input (*dECPt*) = 0.00

Totalizer *dECPt*	Scale Factor
0.00	10
0.0	1
0	.1
x10	.01
x100	.001

Totalizer *dECPt*	Scale Factor
0.000	10
0.00	1
0.0	.1
0	.01
x10	.001

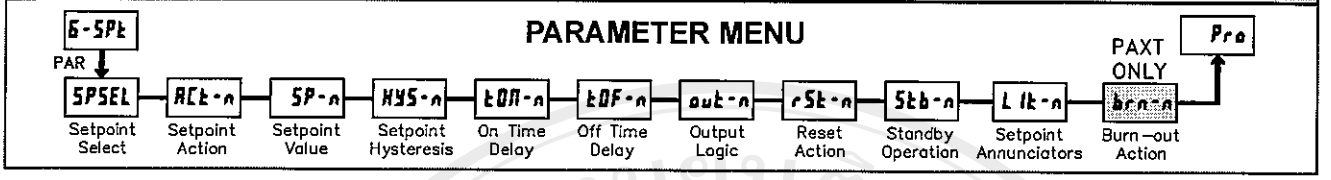
(x = Totalizer display is round by tens or hundreds)

2. To obtain an average reading within a controlled time frame, the selected Totalizer Time Base is divided by the given time period expressed in the same timing units.

Example: Average temperature per hour in a 4 hour period, the scale factor would be 0.250. To achieve a controlled time frame, connect an external timer to a user input programmed for *rtbtE*. The timer will control the start (reset) and the stopping (hold) of the totalizer.

Modules 6, 7, and 8 are accessible only with the appropriate plug-in cards installed. A quick overview of each Module is listed below. Refer to the corresponding plug-in card bulletin for a more detailed explanation of each parameter selection.

5.6 MODULE 6 - SETPOINT (ALARM) PARAMETERS (6-SPt)

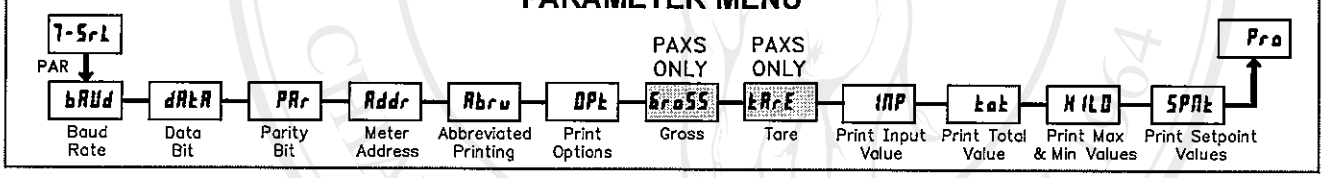


Repeat programming for each setpoint.

SPSEL - SELECT SETPOINT	no	SP-1 SP-3 SP-2 SP-4
ACt-n - SETPOINT ACTION		OFF dE-HI Ab-HI dE-LO Ab-LO bAnd AU-HI toLo AU-LO toHI
SP-n - SETPOINT VALUE		-19999 to 99999
HYS-n - SETPOINT HYSTERESIS		1 to 65000

tON-n - ON TIME DELAY	0.0 to 3275.0 sec	
tOF-n - OFF TIME DELAY	0.0 to 3275.0 sec	
out-n - OUTPUT LOGIC	nor	rEu
rSt-n - RESET ACTION	AUto LAtC2 LAtC1	
Stb-n - STANDBY OPERATION	no	YES
L It-n - SETPOINT ANNUNCIATORS	OFF nor	rEu FLASH
brn-n - PROBE BURN-OUT ACTION PAXT ONLY	on	OFF

5.7 MODULE 7 - SERIAL COMMUNICATIONS PARAMETERS (7-SrL)



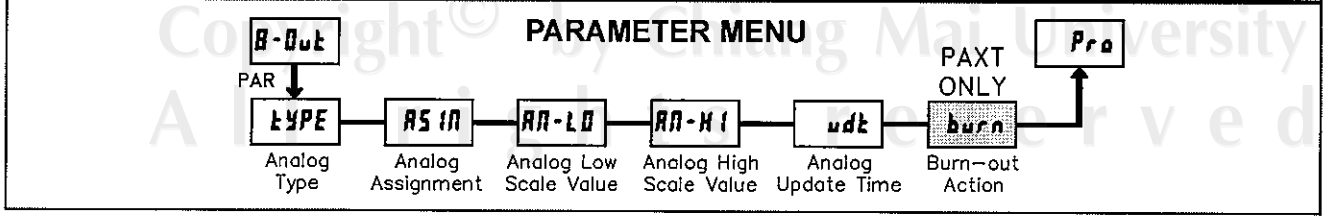
This module is for RS232 and RS485.

bAUd - BAUD RATE	300 600 1200 2400	4800 9600 19200
dAtA - DATA BITS	7	8
PAr - PARITY BIT	Odd EVEN	no

Addr - METER ADDRESS	0 to 99	
Abru - ABBREVIATED PRINTING	no	YES
OPt - PRINT OPTIONS	no	
	YES GroSS	tArE
	inP	H iLO
	tot	SPnt

These two options are for the PAXS ONLY.

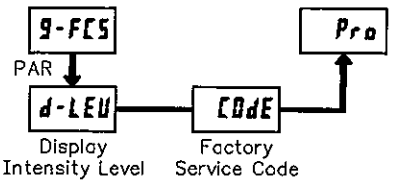
5.8 MODULE 8 - ANALOG OUTPUT PARAMETERS (8-Out)



tYPE - ANALOG TYPE	0-20 4-20	0-10
AS in - ANALOG ASSIGNMENT	inP HI	LO tot

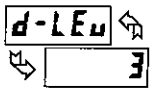
An-LO - ANALOG LOW SCALE VALUE	-19999 to 99999
An-HI - ANALOG HIGH SCALE VALUE	-19999 to 99999
udt - ANALOG UPDATE TIME	0.0 to 10.0 sec.
burn - PROBE BURN-OUT ACTION PAXT ONLY	HI LO

5.9 MODULE 9 - FACTORY SERVICE OPERATIONS (9-FCS)



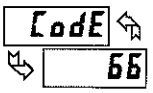
PARAMETER MENU

DISPLAY INTENSITY LEVEL



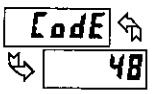
Enter the desired Display Intensity Level (0-15) by using the arrow keys. The display will actively dim or brighten as the levels are changed. This parameter also appears in Quick Programming Mode when enabled.

RESTORE FACTORY DEFAULTS



Use the arrow keys to display CodE 66 and press **PAR**. The meter will display rESEt and then return to CodE 50. Press **DSP** key to return to Display Mode. This will overwrite all user settings with the factory settings.

CALIBRATION



The meter has been fully calibrated at the factory. Scaling to convert the input signal to a desired display value is performed in Module 1. If the meter appears to be indicating incorrectly or inaccurately, refer to Troubleshooting before attempting to calibrate the meter.

When recalibration is required (generally every 2 years), it should only be performed by qualified technicians using appropriate equipment. Calibration does not change any user programmed parameters. However, it may affect the accuracy of the input signal values previously stored using the Apply (APLY) Scaling Style.

Calibration may be aborted by disconnecting power to the meter before exiting Module 9. In this case, the existing calibration settings remain in effect.

PAXD - Input Calibration

WARNING: Calibration of this meter requires a signal source with an accuracy of 0.01% or better and an external meter with an accuracy of 0.005% or better. Resistance inputs require a resistance substitution device with an accuracy of 0.01% or better.

Before starting, verify that the Input Ranger Jumper is set for the range to be calibrated. Also verify that the precision signal source is connected and ready. Allow a 30 minute warm-up period before calibrating the meter. no and **PAR** can be chosen to exit the calibration mode without any changes taking place.

Then perform the following procedure:

1. Use the arrow keys to display CodE 48 and press **PAR**.
2. Choose the range to be calibrated by using the arrow keys and press **PAR**.
3. When the zero range limit appears on the display, apply the appropriate:
   - Voltage ranges: dead short applied
   - Current ranges: open circuit
   - Resistance ranges: dead short with current source connected
4. Press **PAR** and ---- will appear on the display for about 10 seconds.
5. When the top range limit appears on the display, apply the appropriate:
   - Voltage ranges: top range value applied (The 300 V range is the exception. It is calibrated with a 100 V signal.)
   - Current ranges: top range value
   - Resistance ranges: top range value (The ohms calibration requires connection of the internal current source through a resistance substitution device and the proper voltage range selection.)
6. Press **PAR** and ---- will appear on the display for about 10 seconds.
7. When no appears, press **PAR** twice.
8. If the meter is not field scaled, then the input display should match the value of the input signal.
9. Repeat the above procedure for each input range to be calibrated.

PAXP - Input Calibration

WARNING: Calibration of this meter requires a signal source with an accuracy of 0.01% or better and an external meter with an accuracy of 0.005% or better.

Before starting, verify that the precision signal source is connected to the correct terminals and ready. Allow a 30 minute warm-up period before calibrating the meter. no and **PAR** can be chosen to exit the calibration mode without any changes taking place.

Then perform the following procedure:

1. Use the arrow keys to display CodE 48 and press **PAR**.
2. Choose the range to be calibrated by using the arrow keys and press **PAR**. (no and **PAR** can be chosen to exit the calibration mode without any changes taking place.)
3. When the zero range limit appears on the display, apply the appropriate:
   - Voltage range: dead short applied
   - Current range: open circuit
4. Press **PAR** and ---- will appear on the display for about 10 seconds.
5. When the top range limit appears on the display, apply the appropriate:
   - Voltage range: 10 VDC
   - Current range: 20 mADC
6. Press **PAR** and ---- will appear on the display for about 10 seconds.
7. When no appears, press **PAR** twice.
8. If the meter is not field scaled, then the input display should match the value of the input signal.
9. Repeat the above procedure for each input range to be calibrated.

PAXH - Input Calibration

WARNING: In the PAXH, DC signals are used to calibrate the AC ranges. Calibration of the PAXH requires a DC voltmeter with an accuracy of 0.025% and a precision DC signal source capable of:

1. +1% of full scale, DC
2. -1% of full scale, DC
3. +100% of full scale, DC; (300 V range = +100 V calibration)
4. -100% of full scale, DC; (300 V range = -100 V calibration)

Before starting, verify the Input Range and Signal Jumpers are set for the range to be calibrated and the Couple jumper is installed for DC. Also verify the DC signal source is connected and ready. Allow a 30 minute warm-up period before calibrating the meter. no and **PAR** can be chosen to exit the calibration mode without any changes taking place.

Then perform the following procedure:

1. Press the arrow keys to display CodE 48 and press **PAR**.
2. The meter displays CAL. Use the arrow keys to select the range that matches the Signal Jumper setting. Press **PAR**.
3. Apply the signal matching the meter prompt.
4. Press **PAR** and ----- will appear on the display, wait for next prompt.
5. Repeat steps 3 and 4 for the remaining three prompts.
6. When no appears, press **PAR** twice.
7. If the meter is scaled to show input signal, the Input Display should match the value of the input signal in the Display Mode.
8. Repeat the above procedure for each range to be calibrated or to recalibrate the same range. It is only necessary to calibrate the input ranges being used.
9. When all desired calibrations are completed, remove the external signal source and restore original configuration and jumper settings. If AC is being measured, continue with AC Couple Offset Calibration.

AC Couple Offset Calibration - PAXH

It is recommended that Input Calibration be performed first.

1. With meter power removed, set the Input Range Jumper for 20 V, the Couple Jumper for DC, and set the Signal Jumper for voltage by removing the jumper.
2. Connect a wire (short) between Volt (terminal 6) and COMM (terminal 4).
3. Apply meter power.
4. In Module 1, program as follows: Range: 20u; Couple: dC; Decimal Point: 0; Round: 1; Filter: 05; Band: 20; Points: 2; Style: KEY; INP1: 0000; DSP1: 0; INP2: 20000; DSP2: 20000
5. In Module 4, program as follows: Hi-t: 00; Lo-t: 32761
6. Press **PAR** then **DSP** to exit programming and view the Input Display.
7. The readout displays the DC coupled zero input, record the value.
8. Remove the meter power and set the Couple Jumper to AC by removing the jumper.
9. Maintaining the short between terminals 4 and 6, reapply the meter power.
10. Keeping all programming the same, view the Input Display.
11. The readout now displays the AC coupled zero input, record the value.
12. In Module 9, Use the arrow keys to display CodE 48 and press **PAR**.
13. Press the down arrow key twice to AC-OF and press **PAR**.
14. Calculate the offset OFFSt using the following formula:
    OFFSt = AC coupled reading (step 11) - DC coupled reading (step 7)
15. Use the arrow keys to enter the calculated OFFSt.
16. Press **PAR** three times, to exit programming.
17. Remove the meter power and remove the short from terminals 4 and 6.
18. Restore the original jumper and configuration settings.

PAXS - Input Calibration

WARNING: Calibration of this meter requires a signal source with an accuracy of 0.01% or better and an external meter with an accuracy of 0.005% or better.

Before starting, connect -SIG (terminal 4) to COMM (terminal 5). This allows a single ended signal to be used for calibration. Connect the calibration signal to +SIG (terminal 3) and -SIG (terminal 4). Verify the Input Range jumper is in the desired position. Allow a 30 minute warm-up period before calibrating the meter. no and **PAR** can be chosen to exit the calibration mode without any changes taking place. Perform the following procedure:

1. Press the arrow keys to display CAdE 48 and press **PAR**.
2. Choose the range to be calibrated by using the arrow keys and press **PAR**.
3. When the zero range limit appears on the display, apply 0 mV between +SIG and -SIG.
4. Press **PAR** and ---- will appear, wait for next prompt.
5. When the top range limit appears on the display, apply the corresponding +SIG and -SIG voltage (20 mV or 200 mV).
6. Press **PAR** and ---- will appear, on the display for about 10 seconds.
7. When AD appears, press **PAR** twice to exit programming.
8. Repeat the above procedure for each range to be calibrated or to recalibrate the same range. It is only necessary to calibrate the input ranges being used.
9. When all desired calibrations are completed, remove -SIG to COMM connection and external signal source.
10. Restore original configuration and jumper settings.

PAXT - Input Calibration

Warning: Calibration of this meter requires precision instrumentation operated by qualified technicians. It is recommended that a calibration service calibrates the meter.

Before selecting any of the calibration procedures, the input to the meter must be at 0 mV or 0 ohms. Set the digital filer in Module 1 to 1 second. Allow a 30 minute warm-up period before calibrating the meter. The no and **PAR** can be chosen to exit calibration mode without any changes taking place.

10 OHM RTD Range Calibration

1. Set the Input Range Jumper to 10 ohm.
2. Use the arrow keys to display CodE 48 and press **PAR**. Then choose r. 10 and press **PAR**.
3. At 0 r, apply a direct short to input terminals 3, 4 and 5 using a three wire link. Wait 10 seconds, then press **PAR**.
4. At 15 r, apply a precision resistance of 15 ohms (with an accuracy of 0.01% or better) using a three wire link, to input terminals 3, 4 and 5. Wait 10 seconds, then press **PAR**.
5. Connect the RTD, return to the Display Mode and verify the input reading (with 0 Display Offset) is correct. If not correct repeat calibration.

100 OHM RTD Range Calibration

1. Set the Input Range Jumper to 100 ohm.
2. Use the arrow keys to display CodE 48 and press **PAR**. Then choose r. 100 and press **PAR**.
3. At 0 r, apply a direct short to input terminals 3, 4 and 5 using a three wire link. Wait 10 seconds, then press **PAR**.
4. At 300 r, apply a precision resistance of 300 ohms (with an accuracy of 0.01% or better) using a three wire link, to terminals 3, 4 and 5. Wait 10 seconds, press **PAR**.
5. Connect the RTD, return to the Display Mode and verify the input reading (with 0 Display Offset) is correct. If not correct repeat calibration.

THERMOCOUPLE Range Calibration

1. Use the arrow keys to display CodE 48 and press **PAR**. Then choose tC and press **PAR**.
2. At 00 u, apply a dead short or set calibrator to zero to input terminals 4 and 5. Wait 10 seconds, then press **PAR**.
3. At 500 u, apply 50.000 mV input signal (with an accuracy of 0.01% or better) to input terminals 4 and 5. Wait 10 seconds, then press **PAR**.
4. Return to the Display Mode.
5. Continue with Ice Point Calibration.

ICE POINT Calibration

1. **Remove all option cards or invalid results will occur.**
2. The ambient temperature must be within 20°C to 30°C.
3. Connect a thermocouple (types T, E, J, K, or N only) with an accuracy of 1°C or better to the meter.
4. Verify the readout Display Offset is 0, Temperature Scale is °C, Display Resolution is 0.0, and the Input Range is set for the connected thermocouple.
5. Place the thermocouple in close thermal contact to a reference thermometer probe. (Use a reference thermometer with an accuracy of 0.25°C or better.) The two probes should be shielded from air movement and allowed sufficient time to equalize in temperature. (A calibration bath could be used in place of the thermometer.)
6. In the Normal Display mode, compare the readouts.
7. If a difference exists then continue with the calibration.
8. Enter Module 9, use the arrow keys to display CodE 48 and press **PAR**. Then choose ICE and press **PAR**.
9. Calculate a new Ice Point value using: existing Ice Point value + (reference temperature - Display Mode reading). All values are based on °C.
10. Enter the new Ice Point value.
11. Return to the Display Mode and verify the input reading (with 0 Display Offset) is correct. If not correct repeat steps 8 through 10.

ANALOG OUTPUT CARD CALIBRATION

Before starting, verify that the precision voltmeter (voltage output) or current meter (current output) is connected and ready. Perform the following procedure:

1. Use the arrow keys to display CodE 48 and press **PAR**.
2. Use the arrow keys to choose OUt and press **PAR**.
3. Using the chart below, step through the five selections to be calibrated. At each prompt, use the PAX arrow keys to adjust the external meter display to match the selection being calibrated. When the external reading matches, or if this range is not being calibrated, press **PAR**.

SELECTION	EXTERNAL METER	ACTION
00.A	0.00	Adjust if necessary, press PAR
4.00.A	4.00	Adjust if necessary, press PAR
20.00.A	20.00	Adjust if necessary, press PAR
00u	0.00	Adjust if necessary, press PAR
10.00u	10.00	Adjust if necessary, press PAR

4. When AD appears remove the external meters and press **PAR** twice.

TROUBLESHOOTING

PROBLEM	REMEDIES
NO DISPLAY	CHECK: Power level, power connections
PROGRAM LOCKED-OUT	CHECK: Active (lock-out) user input ENTER: Security code requested
MAX, MIN, TOT LOCKED-OUT	CHECK: Module 3 programming
INCORRECT INPUT DISPLAY VALUE	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level, Module 4 Display Offset is zero, press DSP for Input Display PERFORM: Module 9 Calibration (If the above does not correct the problem.)
"OLOL" in DISPLAY (SIGNAL HIGH)	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level
"ULUL" in DISPLAY (SIGNAL LOW)	CHECK: Module 1 programming, Input Range Jumper position, input connections, input signal level
JITTERY DISPLAY	INCREASE: Module 1 filtering, rounding, input range CHECK: Wiring is per EMC installation guidelines
MODULES or PARAMETERS NOT ACCESSIBLE	CHECK: Corresponding plug-in card installation
ERROR CODE (Err 1-4)	PRESS: Reset KEY (If cannot clear contact factory.)
DISPLAY ZERO'S AT LEVELS BELOW 1% OF RANGE	PROGRAM: Module 4 as Hi-t: 0.0 LO-t: 3271.1 (to disable zero chop feature)

For further assistance, contact technical support at the appropriate company numbers listed.

PARAMETER VALUE CHART

Programmer _____ **Date** _____

PAX MODEL NUMBER _____ **Meter#** _____ **Security Code** _____

1- INP Signal Input Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
rANGE	MODEL DEPENDENT		
tYPE	PAXT: INPUT TYPE	tc-J	
SCALE	PAXT: TEMPERATURE SCALE	°F	
COUPL	PAXH: INPUT COUPLE	AC	
dECPt	* DISPLAY RESOLUTION	0	
round	DISPLAY ROUNDING INCREMENT	1	
OFFSt	PAXT: DISPLAY OFFSET	0	
FILtr	FILTER SETTING - PAXH .05	10	
bAnd	FILTER ENABLE BAND - PAXH .0020	10	
ICE	PAXT: ICE POINT SLOPE	0.00	
Pt5	SCALING POINTS	2	
StYLE	SCALING STYLE - NOT PAXT	KEY	
INP 1	* INPUT VALUE 1	0.000	
dSP 1	* DISPLAY VALUE 1	0	
INP 2	* INPUT VALUE 2	1.000	
dSP 2	* DISPLAY VALUE 2	1000	
INP 3	* INPUT VALUE 3	0.000	
dSP 3	* DISPLAY VALUE 3	0	
INP 4	* INPUT VALUE 4	0.000	
dSP 4	* DISPLAY VALUE 4	0	
INP 5	* INPUT VALUE 5	0.000	
dSP 5	* DISPLAY VALUE 5	0	
INP 6	* INPUT VALUE 6	0.000	
dSP 6	* DISPLAY VALUE 6	0	
INP 7	* INPUT VALUE 7	0.000	
dSP 7	* DISPLAY VALUE 7	0	
INP 8	* INPUT VALUE 8	0.000	
dSP 8	* DISPLAY VALUE 8	0	
INP 9	* INPUT VALUE 9	0.000	
dSP 9	* DISPLAY VALUE 9	0	
INP 10	* INPUT VALUE 10	0.000	
dSP 10	* DISPLAY VALUE 10	0	
INP 11	* INPUT VALUE 11	0.000	
dSP 11	* DISPLAY VALUE 11	0	
INP 12	* INPUT VALUE 12	0.000	
dSP 12	* DISPLAY VALUE 12	0	
INP 13	* INPUT VALUE 13	0.000	
dSP 13	* DISPLAY VALUE 13	0	
INP 14	* INPUT VALUE 14	0.000	
dSP 14	* DISPLAY VALUE 14	0	
INP 15	* INPUT VALUE 15	0.000	
dSP 15	* DISPLAY VALUE 15	0	
INP 16	* INPUT VALUE 16	0.000	
dSP 16	* DISPLAY VALUE 16	0	

* Decimal point location is model and programming dependent.

2-FNC User Input and Function Key Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
USr-1	USER INPUT 1	NO	
USr-2	USER INPUT 2	NO	
USr-3	USER INPUT 3	NO	
F1	FUNCTION KEY 1	NO	
F2	FUNCTION KEY 2	NO	
rSt	RESET KEY	NO	
Sc-F1	2nd FUNCTION KEY 1	NO	
Sc-F2	2nd FUNCTION KEY 2	NO	

3-LOC Display and Program Lockout Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
HI	MAX DISPLAY LOCKOUT	LOC	
LO	MIN DISPLAY LOCKOUT	LOC	
tOt	TOTAL DISPLAY LOCKOUT	LOC	
SP-1	SETPOINT 1 ACCESS	LOC	
SP-2	SETPOINT 2 ACCESS	LOC	
SP-3	SETPOINT 3 ACCESS	LOC	
SP-4	SETPOINT 4 ACCESS	LOC	
CodE	SECURITY CODE	0	

4-SEC Secondary Function Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
HI-t	MAX CAPTURE DELAY TIME	0.0	
LO-t	MIN CAPTURE DELAY TIME	0.0	
dSP-t	DISPLAY UPDATE TIME	2	
AZ-t	PAXS: AUTO-ZERO DELAY	0	
AZ-b	PAXS: AUTO-ZERO BAND	0.02	
b-LIt	UNITS LABEL BACKLIGHT - PAXT	ON	OFF
OFFSt	DISPLAY OFFSET - NOT PAXT	000	
ICE	PAXT: ICE POINT COMPENSATION	ON	

5-tOt Totalizer (Integrator) Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
dECPt	* TOTALIZER DECIMAL POINT	0	
tbASE	TOTALIZER TIME BASE	.1M	
SCFAC	TOTALIZER SCALE FACTOR	1000	
Locut	* TOTALIZER LOW CUT VALUE	-19999	
P-UP	TOTALIZER POWER-UP RESET	NO	

7-SrL Serial Communication Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
bAUd	BAUD RATE	9600	
dAtA	DATA BIT	7	
PAr	PARITY BIT	Odd	
Addr	METER ADDRESS	0	
Abru	ABBREVIATED PRINTING	YES	
OPt	ENTER PRINT OPTIONS	NO	
GroSS	PAXS: PRINT GROSS OFFSET	NO	
tArE	PAXS: PRINT TARE OFFSET	NO	
INP	PRINT INPUT VALUE	YES	
tot	PRINT TOTAL VALUE	YES	
HILO	PRINT MAX & MIN VALUES	YES	
SPNt	PRINT SETPOINT VALUES	NO	

8-Out Analog Output Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
tYPE	ANALOG TYPE	4-20	
AS IN	ANALOG ASSIGNMENT	INP	
AN-LO	* ANALOG LOW SCALE VALUE	0	
AN-HI	* ANALOG HIGH SCALE VALUE	1000	
udt	ANALOG UPDATE TIME	0.0	
burn	PAXT: PROBE BURN-OUT ACTION	LO	

9-FCS Factory Setting Parameters

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
d-LEu	DISPLAY INTENSITY LEVEL	3	

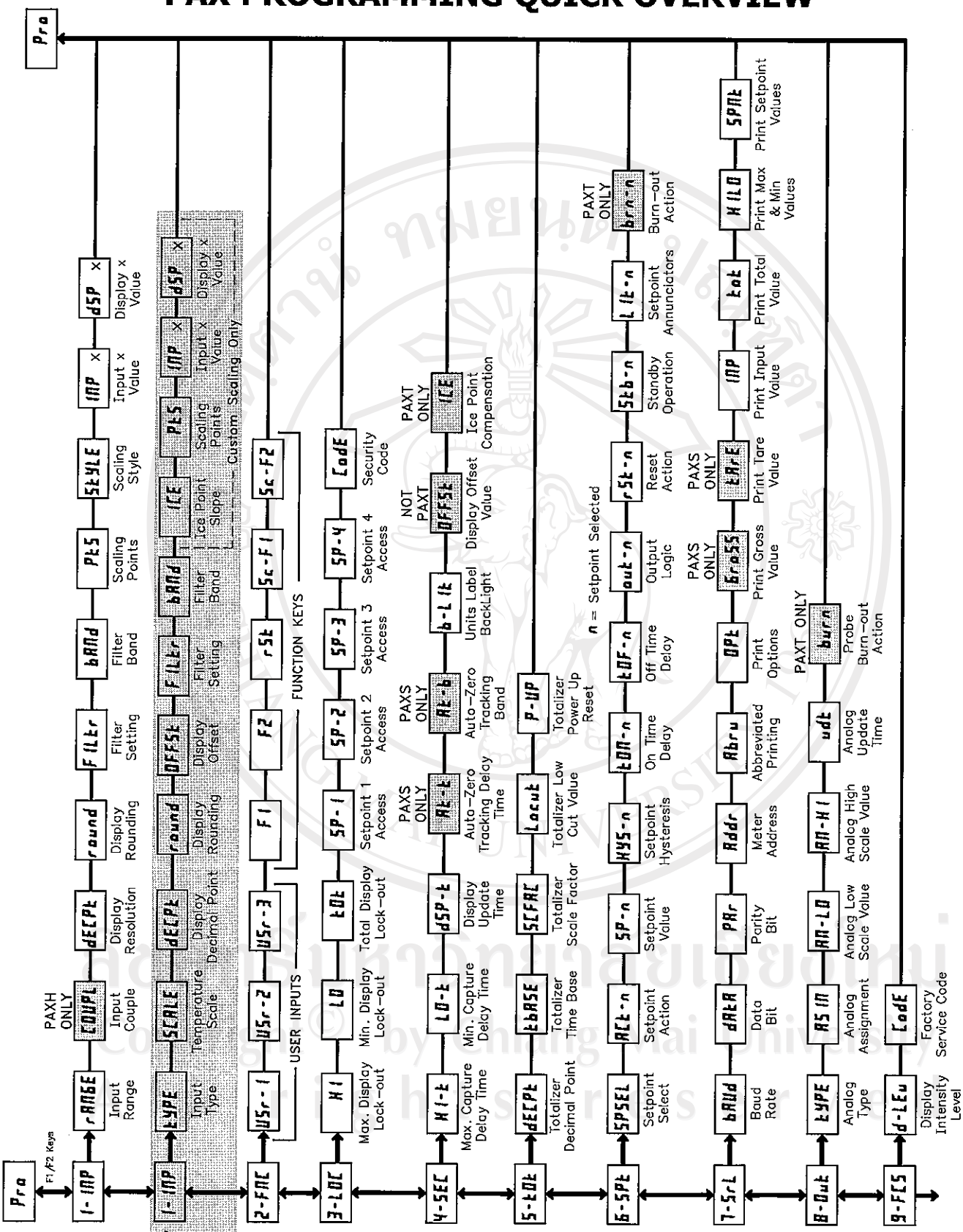
6-SPt Setpoint (Alarm) Parameters

DISPLAY	PARAMETER	SP-1 FACTORY SETTING	SP-1 USER SETTING	SP-2 FACTORY SETTING	SP-2 USER SETTING	SP-3 FACTORY SETTING	SP-3 USER SETTING	SP-4 FACTORY SETTING	SP-4 USER SETTING
ACt-n	SETPOINT ACTION	OFF		OFF		OFF		OFF	
SP-n	* SETPOINT VALUE (main)	100		200		300		400	
	* SETPOINT VALUE (alternate) †	100		200		300		400	
HYS-n	* SETPOINT HYSTERESIS	2		2		2		2	
tON-n	ON TIME DELAY	0.0		0.0		0.0		0.0	
tOF-n	OFF TIME DELAY	0.0		0.0		0.0		0.0	
out-n	OUTPUT LOGIC	nor		nor		nor		nor	
rSt-n	RESET ACTION	AUto		AUto		AUto		AUto	
Stb-n	STANDBY OPERATION	NO		NO		NO		NO	
LIt-n	SETPOINT ANNUNCIATORS	nor		nor		nor		nor	
brn-n	PAXT: PROBE BURN-OUT ACTION	OFF		OFF		OFF		OFF	

† Select alternate list to program these values.

* Decimal point location is model and programming dependent.

PAX PROGRAMMING QUICK OVERVIEW



LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.

Red Lion Controls
20 Willow Springs Circle
York PA 17406
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839

Red Lion Controls BV
Printerweg 10
NL - 3821 AD Amersfoort
Tel +31 (0) 334 723 225
Fax +31 (0) 334 893 793

Red Lion Controls AP
31, Kaki Bukit Road 3,
#06-04/05 TechLink
Singapore 417818
Tel +65 6744-6613
Fax +65 6743-3360

red lion
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion.net

Bulletin No. PAXCDS-E
Drawing No. LP0400
Released 11/07

MODEL PAXCDS -SETPOINT OUTPUT PLUG-IN OPTION CARDS

DESCRIPTION

This bulletin serves as a guide for the installation, configuration and operation of PAX Setpoint cards. The setpoint cards are available as dual relay, quad relay, quad sourcing transistor, or quad sinking transistor outputs. Only one setpoint card can be installed at a time.

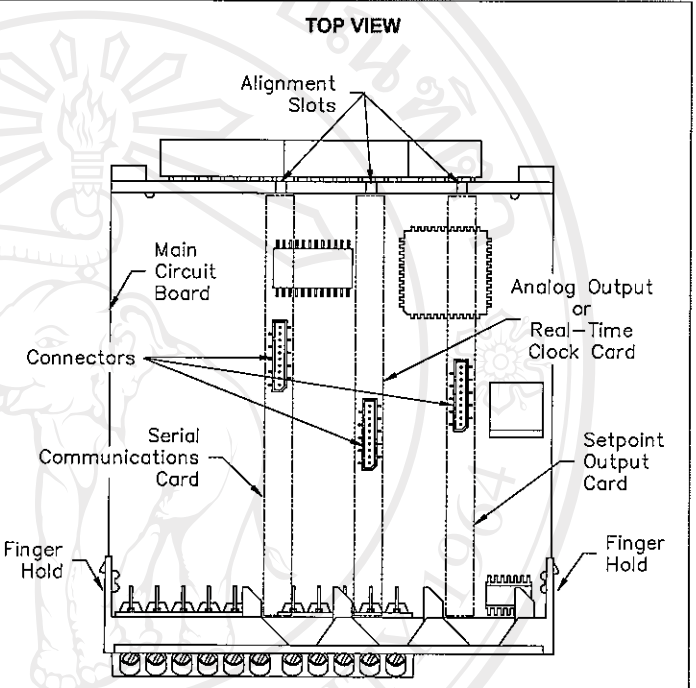
The PAX meter can be fitted with up to three option cards. The slot bays of the option cards are dedicated to a particular card function. The option card functions are: serial communications, analog output and setpoint output. Only one card from each function category can be installed.

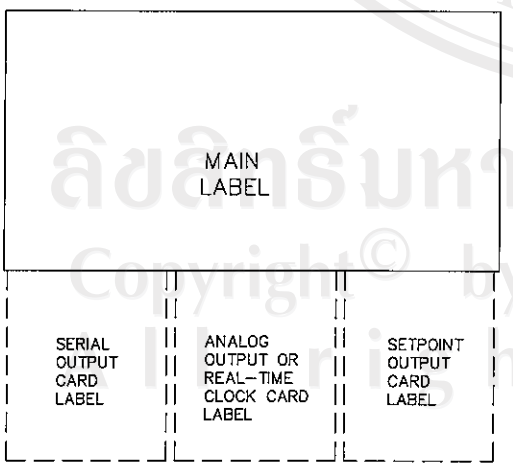
INSTALLING AN OPTION CARD

Caution: The option and main circuit cards contain static sensitive components. Before handling the cards, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the cards at a static controlled clean workstation. Also, only handle the cards by the edges. Dirt, oil or other contaminants that may contact the cards can adversely affect circuit operation.

Warning: Exposed line voltage exists on the circuit boards. Remove all power to the meter AND load circuits before accessing the unit.

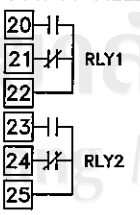
1. Remove the main assembly from the rear of the case. Squeeze the finger holds on the rear cover, or use a small screwdriver to depress the side latches to release it from the case. It is not necessary to separate the rear cover from the main circuit card.
2. Locate the option card connector for the type of option card to be installed. Hold the unit by the rear connector, not the display board, when installing an option card.
3. Install the option card by aligning the option card connector with the slot in the rear cover. The cards are keyed by position with different main board connector locations. Be sure the connector is fully engaged and the tab on the option card rests in the alignment slot on the display board.
4. Slide the assembly back into the case. Be sure the rear cover latches fully into the case.
5. Apply the option card label to the bottom side of the meter. **Do not cover the vents on the top surface of the meter.** The surface of the case must be clean for the label to adhere properly. Apply the label to the area designated by the large case label.



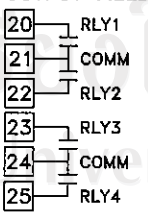


PAX REAR TERMINAL CONNECTIONS

DUAL RELAY PAXCDS10 OUTPUT FIELD TERMINALS



QUAD RELAY PAXCDS20 OUTPUT FIELD TERMINALS



QUAD SINKING PAXCDS30 OUTPUT FIELD TERMINALS

20	– COMMON
21	– 01 SNK.
22	– 02 SNK.
23	– 03 SNK.
24	– 04 SNK.
25	– COMMON

QUAD SOURCING PAXCDS40 OUTPUT FIELD TERMINALS

20	– EXTERNAL SUPPLY
21	– 01 SRC.
22	– 02 SRC.
23	– 03 SRC.
24	– 04 SRC.
25	– COMMON

SPECIFICATIONS

Setpoint Output Cards: Four types of field installable cards

Response Time: 200 msec. max. to within 99% of final readout value (digital filter and internal zero correction disabled)700 msec. max. (digital filter disabled, internal zero correction enabled)
PAXH only: 1 sec. max. to within 99% of final readout value (digital filter disabled)
PAXT only: 200 msec. typ.; 700 msec max. (digital filter disabled)

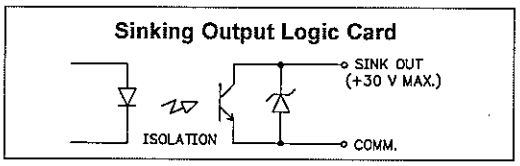
PAXH Isolation For All Four Cards:
Isolation To Sensor Common: 1400 Vrms for 1 min.
Working Voltage: 125 V
Isolation To User Input Common: 500 Vrms for 1 min.
Working Voltage: 50 V

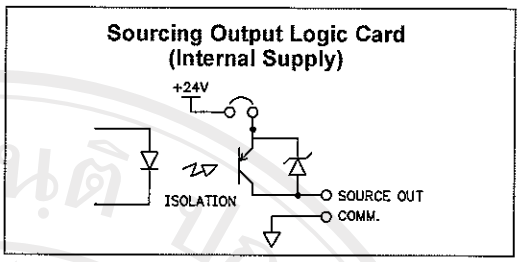
Dual Relay Card: PAXCDS10
Type: Two FORM-C relays
Isolation To Sensor & User Input Commons: 2000 Vrms for 1 min.
Working Voltage: 250 V
Contact Rating:
One Relay Energized: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @120 VAC, inductive load
Total Current With Both Relays Energized not to exceed 5 amps
Life expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

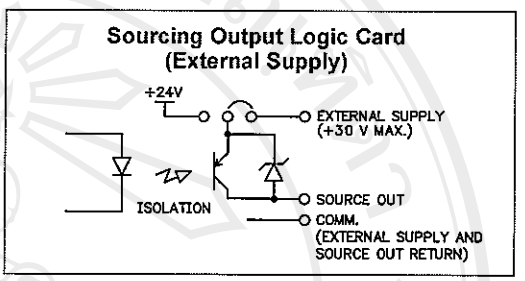
Quad Relay Card: PAXCDS20
Type: Four FORM-A relays
Isolation To Sensor & User Input Commons: 2300 Vrms for 1 min.
Working Voltage: 250 V
Contact Rating:
One Relay Energized: 3 amps @ 250 VAC or 30 VDC (resistive load), 1/10 HP @120 VAC, inductive load
Total Current With All Four Relays Energized not to exceed 4 amps
Life Expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

Quad Sinking Open Collector: PAXCDS30
Type: Four isolated sinking NPN transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Rating: 100 mA max @ V_{SAT} = 0.7 V max. V_{MAX} = 30 V

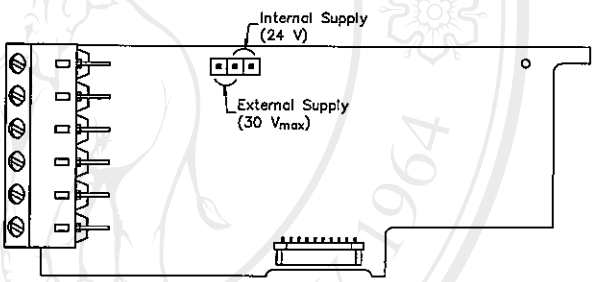
Quad Sourcing Open Collector: PAXCDS40
Type: Four isolated sourcing PNP transistors.
Isolation To Sensor & User Input Commons: 500 Vrms for 1 min.
Working Voltage: 50 V. Not Isolated from all other commons.
Rating: Internal supply: 24 VDC ± 10% , 30 mA max. total all four
External supply: 30 VDC max., 100 mA max each output







Quad Sourcing Open Collector Output Card Supply Select

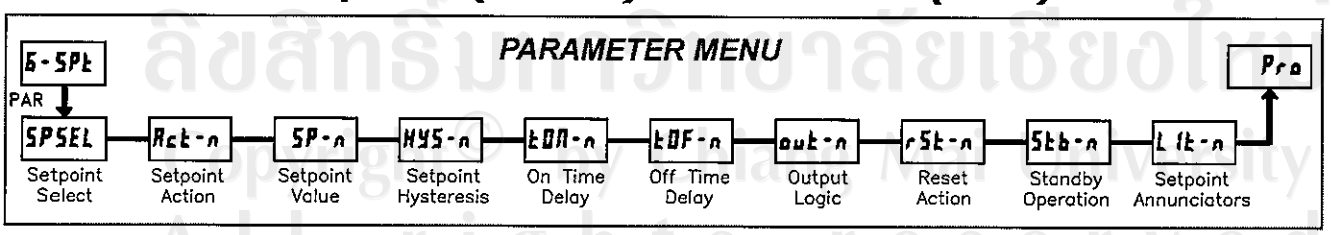


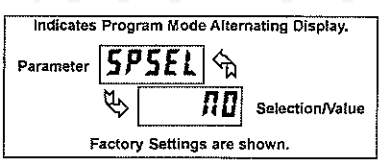
For Quad Sourcing Plug-in Card (PAXCDS40), set the jumper for internal or external supply operation before applying power.

ORDERING INFORMATION

MODEL	DESCRIPTION	PART NUMBER
PAXCDS	Dual Relay Output Card	PAXCDS10
	Quad Relay Output Card	PAXCDS20
	Quad Sinking Open Collector Output Card	PAXCDS30
	Quad Sourcing Open Collector Output Card	PAXCDS40

MODULE 6 - Setpoint (Alarm) Parameters (6-SPt)





SETPOINT SELECT

n0 SP-1 SP-2
SP-3 SP-4

Enter the setpoint (alarm output) to be programmed. The n in the following parameters will reflect the chosen setpoint number. After the chosen setpoint is completely programmed, the display will return to SPSEL n0. Repeat step for each setpoint to be programmed. The n0 chosen at SPSEL will return to PRO n0. The number of setpoints available is setpoint output card dependent.

SETPOINT ACTION

Act-n ↺ OFF Ab-HI Ab-LO AU-HI AU-LO dE-HI dE-LO bAnd totLo totHI

↻ OFF

Enter the action for the selected setpoint (alarm output). See Setpoint Alarm Figures for a visual detail of each action.

OFF	=	Setpoint always off, (returns to SPSEL NO)
Ab-HI	=	Absolute high, with balanced hysteresis
Ab-LO	=	Absolute low, with balanced hysteresis
AU-HI	=	Absolute high, with unbalanced hysteresis
AU-LO	=	Absolute low, with unbalanced hysteresis
dE-HI	=	Deviation high, with unbalanced hysteresis *
dE-LO	=	Deviation low, with unbalanced hysteresis *
bAnd	=	Outside band, with unbalanced hysteresis *
totLo	=	Lower Totalizer absolute high, unbalance hysteresis**
totHI	=	Upper Totalizer absolute high, unbalance hysteresis**

* Deviation and band action setpoints are relative to the value of setpoint 1. It is not possible to configure setpoint 1 as deviation or band actions. It is possible to use setpoint 1 for an absolute action, while its value is being used for deviation or band.

** The lower Totalizer action totLo allows setpoints to function off of the lower 5 digits of the Totalizer. The upper Totalizer action totHI allows setpoints to function off of the upper 4 digits of the Totalizer. To obtain absolute low alarms for the Totalizer, program the totLo or totHI output logic as reverse.

SETPOINT VALUE

SP-n ↺ - 19999 to 99999

↻ 10.00

Enter desired setpoint alarm value. These setpoint values can also be entered in the Display Mode during Program Lock-out when the setpoint is programmed as Ent in Parameter Module 3. When a setpoint is programmed as deviation or band acting, the associated output tracks SP 1 as it is changed. The value entered is the offset, or difference from SP 1.

HYSTERESIS VALUE

HYS-n ↺ 1 to 65000

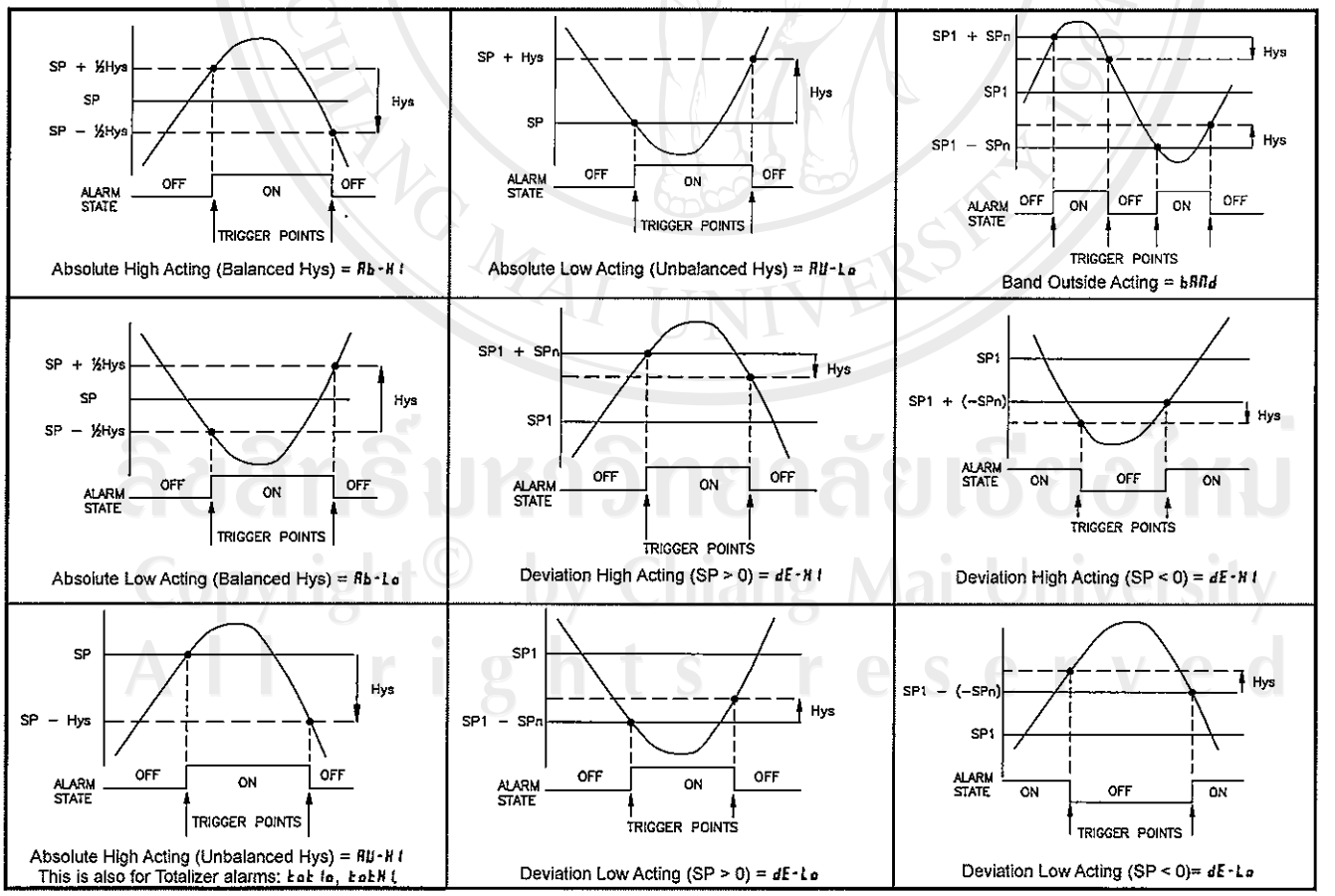
↻ 0.02

Enter desired hysteresis value. See Setpoint Alarm Figures for visual explanation of how setpoint alarm actions (balance and unbalance) are affected by the hysteresis. When the setpoint is a control output, usually balance hysteresis is used. For alarm applications, usually unbalanced hysteresis is used. For unbalanced hysteresis modes, the hysteresis functions on the low side for high acting setpoints and functions on the high side for low acting setpoints.

Note: Hysteresis eliminates output chatter at the switch point, while time delay can be used to prevent false triggering during process transient events.

Setpoint Alarm Figures

With reverse output logic rEu, the below alarm states are opposite.



ON TIME DELAY

tOn-n
0.0

0.0 to 3275.0 Sec

Enter the time value in seconds that the alarm is delayed from turning on after the trigger point is reached. A value of 0.0 allows the meter to update the alarm status per the response time listed in the Specifications. When the output logic is rEu, this becomes off time delay. Any time accumulated at power-off resets during power-up.

OFF TIME DELAY

tOF-n
0.0

0.0 to 3275.0 Sec

Enter the time value in seconds that the alarm is delayed from turning off after the trigger point is reached. A value of 0.0 allows the meter to update the alarm status per the response time listed in the Specifications. When the output logic is rEu, this becomes on time delay. Any time accumulated at power-off resets during power-up.

OUTPUT LOGIC

out-n
nor

nor rEu

Enter the output logic of the alarm output. The nor logic leaves the output operation as normal. The rEu logic reverses the output logic. In rEu, the alarm states in the Setpoint Alarm Figures are reversed.

RESET ACTION

rSt-n
Auto

Auto LAtC1 LAtC2

Enter the reset action of the alarm output.

Auto = Automatic action; This action allows the alarm output to automatically reset off at the trigger points per the Setpoint Action shown in Setpoint Alarm Figures. The "on" alarm may be manually reset (off) immediately by a front panel function key or user input.The alarm remains reset off until the trigger point is crossed again.

LAtC1 = Latch with immediate reset action; This action latches the alarm output on at the trigger point per the Setpoint Action shown in Setpoint Alarm Figures. Latch means that the alarm output can only be turned off by front panel function key or user input manual reset, serial reset command or meter power cycle. When the user input or function key is activated (momentary or maintained), the corresponding "on" alarm output is reset immediately and remains off until the trigger point is crossed again. (Previously latched alarms will be off if power up Display Value is lower than setpoint value.)

LAtC2 = Latch with delay reset action; This action latches the alarm output on at the trigger point per the Setpoint Action shown in Setpoint Alarm Figures. Latch means that the alarm output can only be turned off by front panel function key or user input manual reset, serial reset command or meter power cycle. When the user input or function key is activated (momentary or maintained), the meter delays the event until the corresponding "on" alarm output crosses the trigger off point. (Previously latched alarms are off if power up Display Value is lower than setpoint value. During a power cycle, the meter erases a previous Latch 2 reset if it is not activated at power up.)

STANDBY OPERATION

Stb-n
no

no YES

When YES, the alarm is disabled (after a power up) until the trigger point is crossed. Once the alarm is on, the alarm operates normally per the Setpoint Action and Reset Mode.

SETPOINT ANNUNCIATORS

Lit-n
nor

OFF nor rEu FLASH

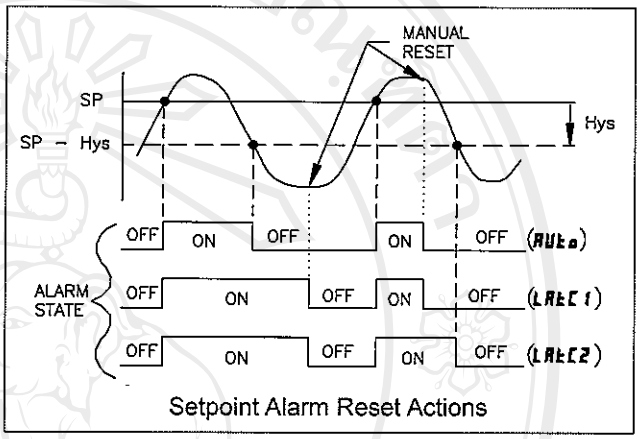
The OFF mode disables display setpoint annunciators. The nor mode displays the corresponding setpoint annunciators of "on" alarm outputs. The rEu mode displays the corresponding setpoint annunciators of "off" alarms outputs. The FLASH mode flashes the corresponding setpoint annunciators of "on" alarm outputs.

PROBE BURN-OUT ACTION (PAXT ONLY)

brn-n
oFF

on OFF

Enter the probe burn-out action. In the event of a temperature probe failure, the alarm output can be programmed to go on or off.



Setpoint Alarm Reset Actions

Alternate Setpoints

An Alternate list of setpoint values can be stored and recalled as needed. The Alternate list allows an additional set of setpoint values. (The setpoint numbers nor rear terminal numbers will change in the Alternate list.) The Alternate list can only be activated through a function key or user input programmed for L ISt in Module 2. When the Alternate list is selected, the Main list is stored and becomes inactive. When changing between Main and Alternate, the alarm state of Auto Reset Action alarms will always follow their new value. Latched "on" alarms will always stay latched during the transition and can only be reset with a user input or function key. Only during the function key or user input transition does the display indicate which list is being used.

LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.

Red Lion Controls
20 Willow Springs Circle
York PA 17406
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839

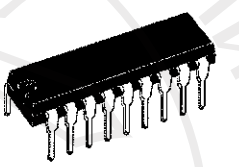
Red Lion Controls BV
Printerweg 10
NL - 3821 AD Amersfoort
Tel +31 (0) 334 723 225
Fax +31 (0) 334 893 793

Red Lion Controls AP
Unit 101, XinAn Plaza
Building 13, No.99 Tianzhou Road
ShangHai, P.R. China 200223
Tel +86 21 6113-3688
Fax +86 21 6113-3683

ULN2801A
ULN2802A - ULN2803A
ULN2804A - ULN2805A

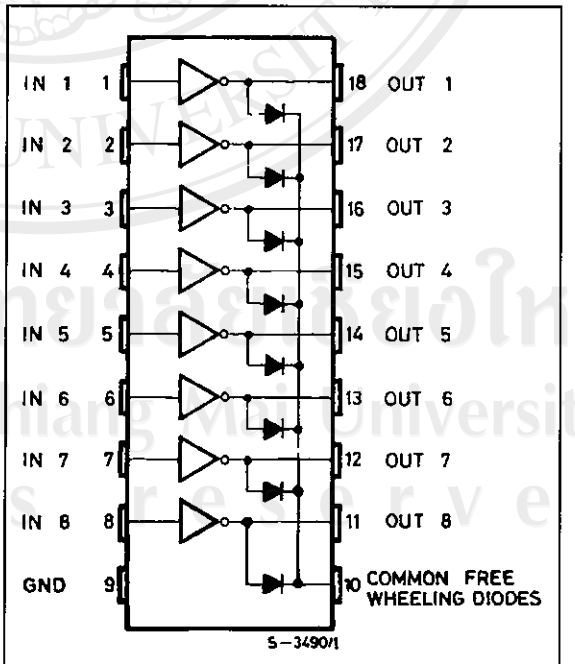
EIGHT DARLINGTON ARRAYS

- EIGHT DARLINGTONS WITH COMMON EMITTERS
- OUTPUT CURRENT TO 500 mA
- OUTPUT VOLTAGE TO 50 V
- INTEGRAL SUPPRESSION DIODES
- VERSIONS FOR ALL POPULAR LOGIC FAMILIES
- OUTPUT CAN BE PARALLELED
- INPUTS PINNED OPPOSITE OUTPUTS TO SIMPLIFY BOARD LAYOUT



DIP18

PIN CONNECTION (top view)



DESCRIPTION

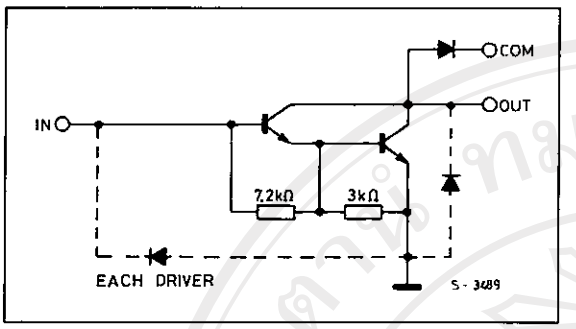
The ULN2801A-ULN2805A each contain eight darlington transistors with common emitters and integral suppression diodes for inductive loads. Each darlington features a peak load current rating of 600mA (500mA continuous) and can withstand at least 50V in the off state. Outputs may be paralleled for higher current capability.

Five versions are available to simplify interfacing to standard logic families : the ULN2801A is designed for general purpose applications with a current limit resistor ; the ULN2802A has a 10.5kΩ input resistor and zener for 14-25V PMOS ; the ULN2803A has a 2.7kΩ input resistor for 5V TTL and CMOS ; the ULN2804A has a 10.5kΩ input resistor for 6-15V CMOS and the ULN2805A is designed to sink a minimum of 350mA for standard and Schottky TTL where higher output current is required.

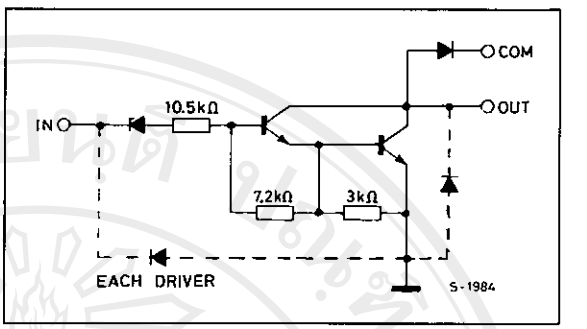
All types are supplied in a 18-lead plastic DIP with a copper lead from and feature the convenient input-opposite-output pinout to simplify board layout.

SCHEMATIC DIAGRAM AND ORDER CODES

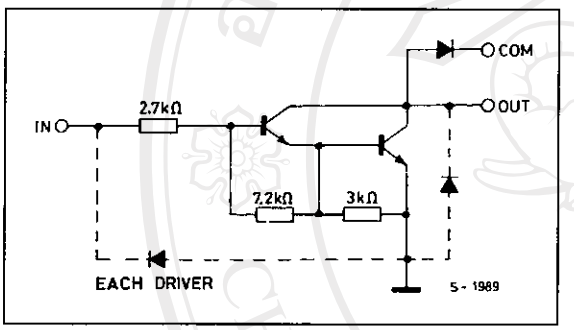
For ULN2801A (each driver for PMOS-CMOS)



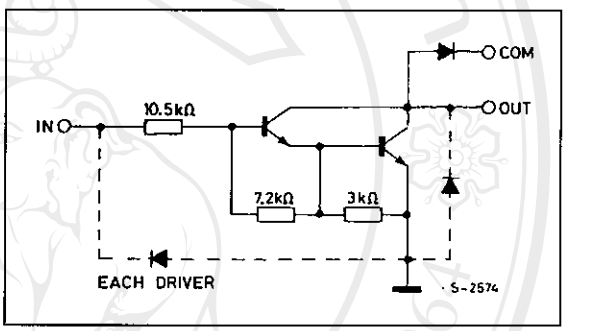
For ULN2802A (each driver for 14-15 V PMOS)



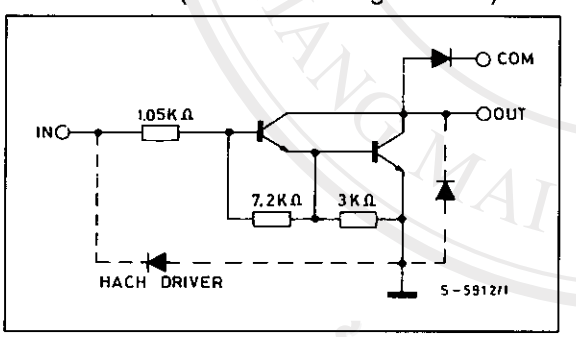
For ULN2803A (each driver for 5 V, TTL/CMOS)



For ULN2804A (each driver for 6-15 V CMOS/PMOS



For ULN2805A (each driver for high out TTL)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_o	Output Voltage	50	V
V_i	Input Voltage for ULN2802A, UL2803A, ULN2804A for ULN2805A	 30 15	V
I_C	Continuous Collector Current	500	mA
I_B	Continuous Base Current	25	mA
P_{tot}	Power Dissipation (one Darlington pair) (total package)	 1.0 2.25	W
T_{amb}	Operating Ambient Temperature Range	– 20 to 85	°C
T_{stg}	Storage Temperature Range	– 55 to 150	°C
Tj	Junction Temperature Range	– 20 to 150	°C

THERMAL DATA

Symbol	Parameter		Value	Unit
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max.	55	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
I_{CEX}	Output Leakage Current	V_{CE} = 50V T_{amb} = 70°C, V_{CE} = 50V T_{amb} = 70°C for ULN2802A V_{CE} = 50V, V_i = 6V for ULN2804A V_{CE} = 50V, V_i = 1V			50 100 500 500	µA µA µA µA	1a 1a 1b 1b
$V_{CE(sat)}$	Collector-emitter Saturation Voltage	I_C = 100mA, I_B = 250µA I_C = 200mA, I_B = 350µA I_C = 350mA, I_B = 500µA		0.9 1.1 1.3	1.1 1.3 1.6	V V V	2
$I_{i(on)}$	Input Current	for ULN2802A V_i = 17V for ULN2803A V_i = 3.85V for ULN2804A V_i = 5V V_i = 12V for ULN2805A V_i = 3V		0.82 0.93 0.35 1 1.5	1.25 1.35 0.5 1.45 2.4	mA mA mA mA mA	3
$I_{i(off)}$	Input Current	T_{amb} = 70°C, I_C = 500µA	50	65		µA	4
$V_{i(on)}$	Input Voltage	V_{CE} = 2 V for ULN2802A I_C = 300mA for ULN2803A I_C = 200mA I_C = 250mA I_C = 300mA for ULN2804A I_C = 125mA I_C = 200mA I_C = 275mA I_C = 350mA for ULN2805A I_C = 350mA			 13 2.4 2.7 3 5 6 7 8 2.4	 V V V V V V V V V	5
h_{FE}	DC Forward Current Gain	for ULN2801A V_{CE} = 2V, I_C = 350mA	1000			–	2
C_i	Input Capacitance			15	25	pF	–
t_{PLH}	Turn-on Delay Time	0.5 V_i to 0.5 V_o		0.25	1	µs	–
t_{PHL}	Turn-off Delay Time	0.5 V_i to 0.5 V_o		0.25	1	µs	–
I_R	Clamp Diode Leakage Current	V_R = 50V T_{amb} = 70°C, V_R = 50V			50 100	µA µA	6 6
V_F	Clamp Diode Forward Voltage	I_F = 350mA		1.7	2	V	7

TEST CIRCUITS

Figure 1a.

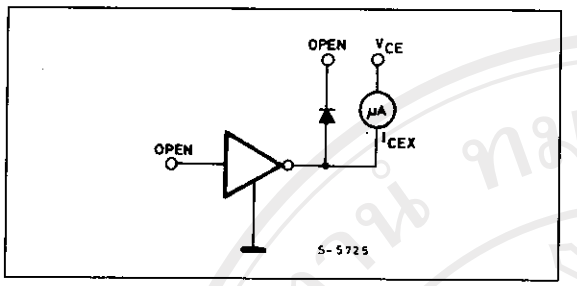


Figure 1b.

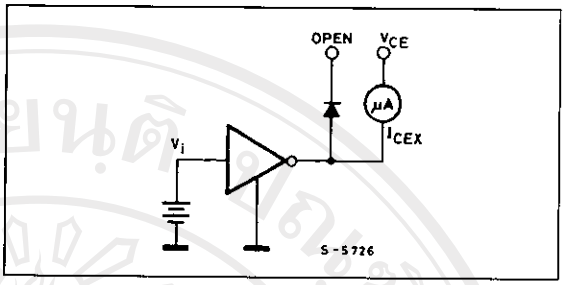


Figure 2.

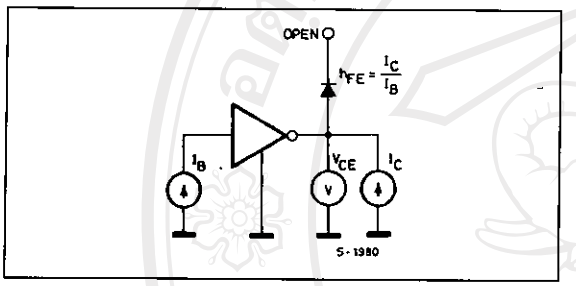


Figure 3.

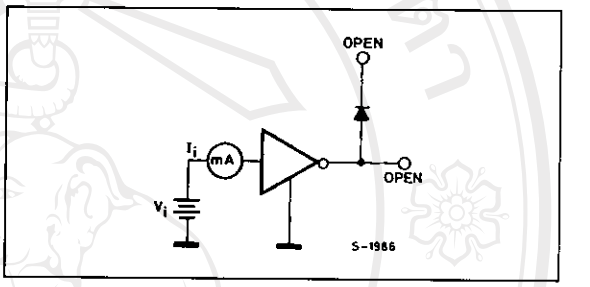


Figure 4.

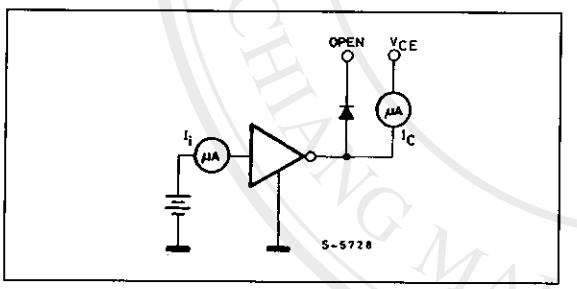


Figure 5.

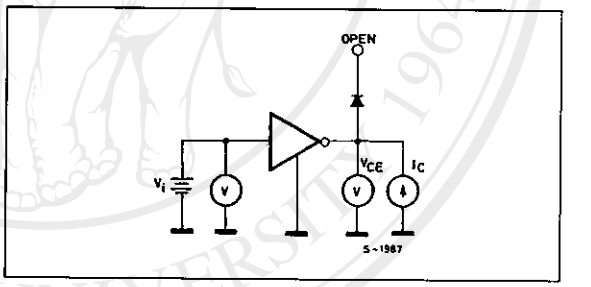


Figure 6.

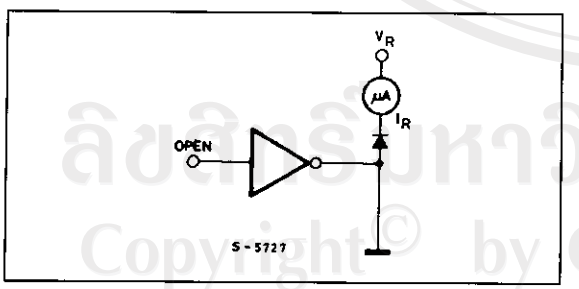


Figure 7.

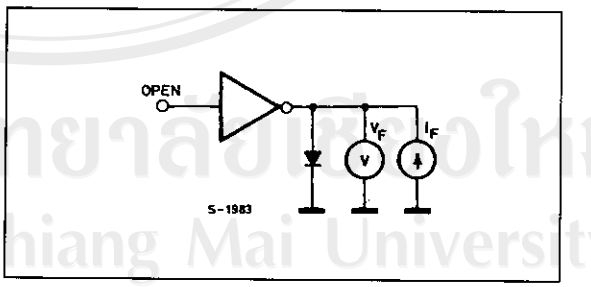


Figure 8 : Collector Current as a Function of Saturation Voltage.

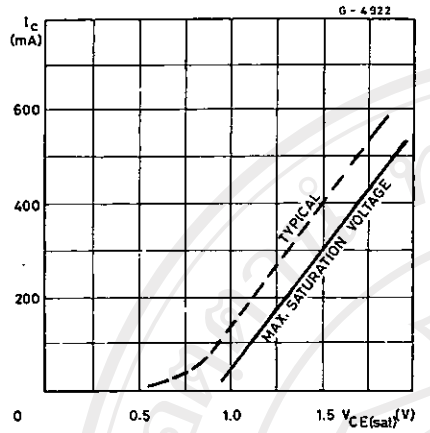


Figure 9 : Collector Current as a Function of Input Current.

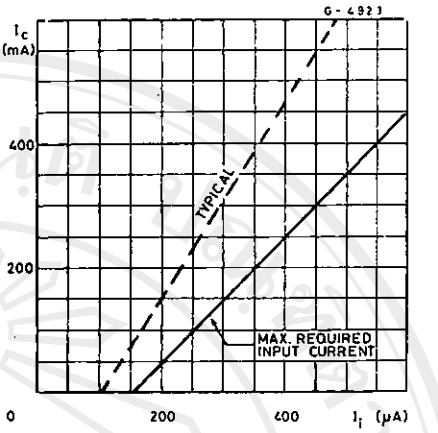


Figure 10 : Allowable Average Power Dissipation as a Function of Ambient Temperature.

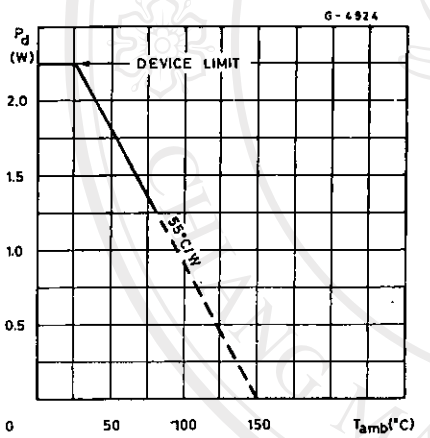


Figure 11 : Peak Collector Current as a Function of Duty Cycle.

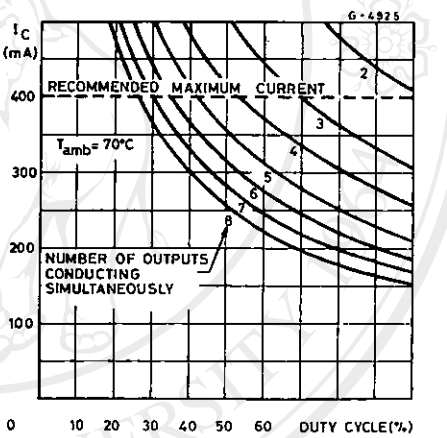


Figure 12 : Peak Collector Current as a Function of Duty.

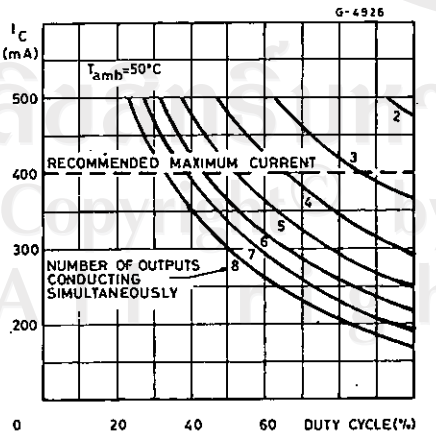


Figure 13 : Input Current as a Function of Input Voltage (for ULN2802A).

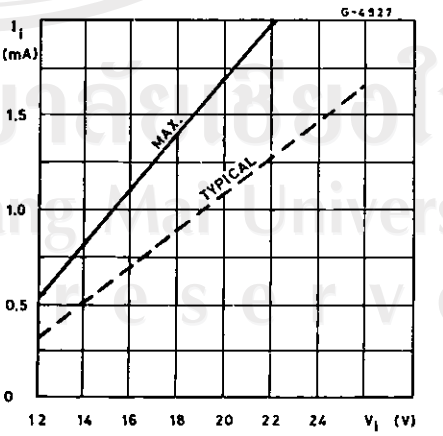


Figure 14 : Input Current as a Function of Input Voltage (for ULN2804A)

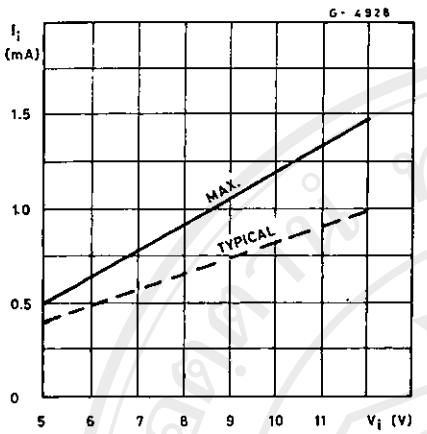


Figure 15 : Input Current as a Function of Input Voltage (for ULN2803A)

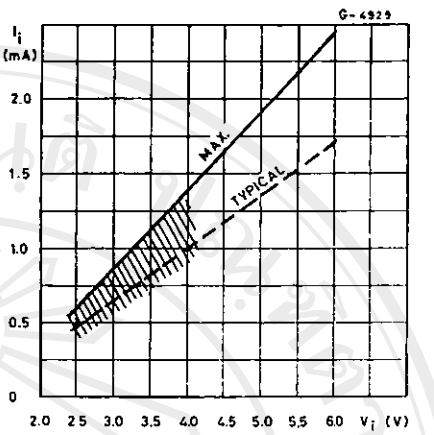
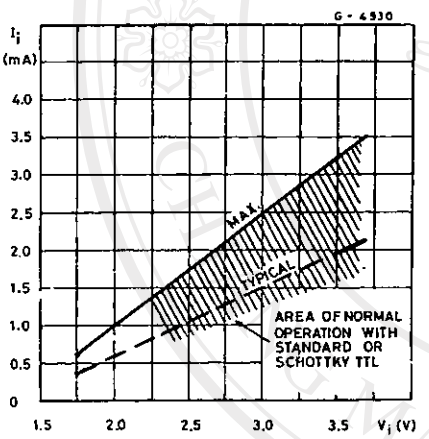
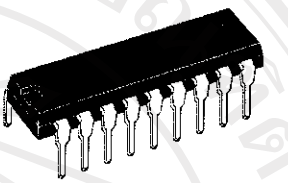


Figure 16 : Input Current as a Function of Input Voltage (for ULN2805A)

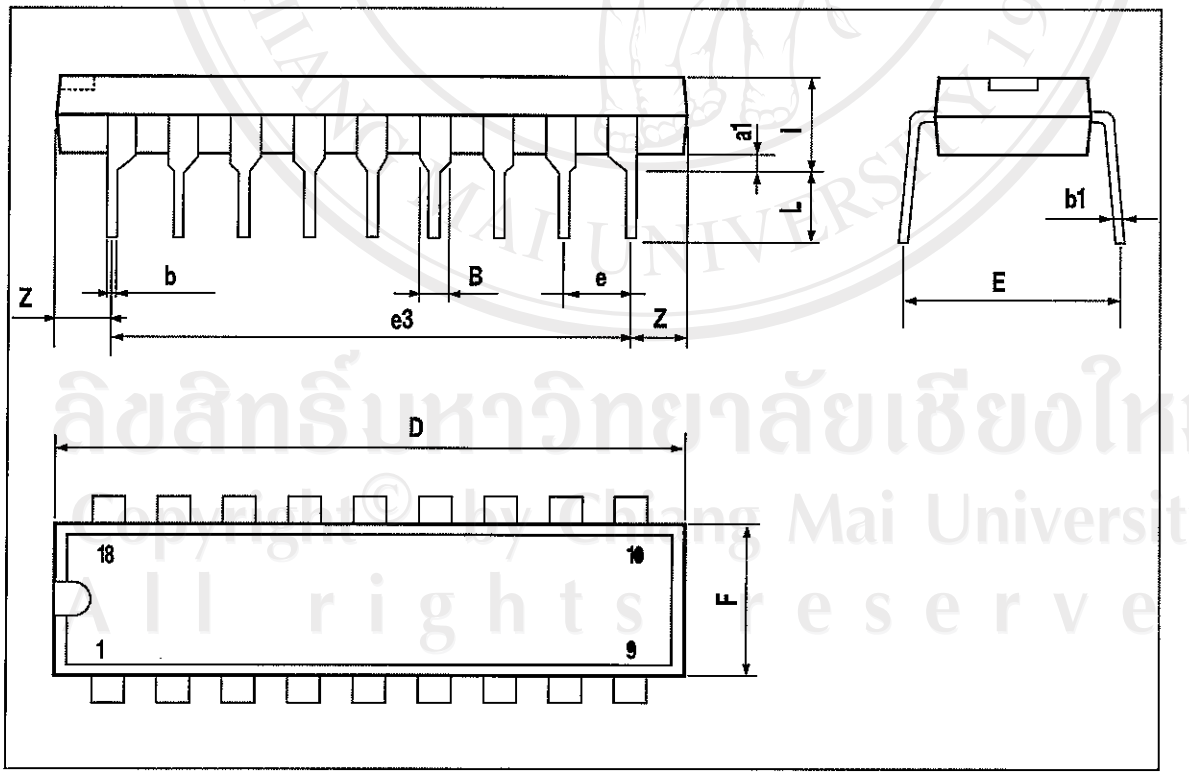


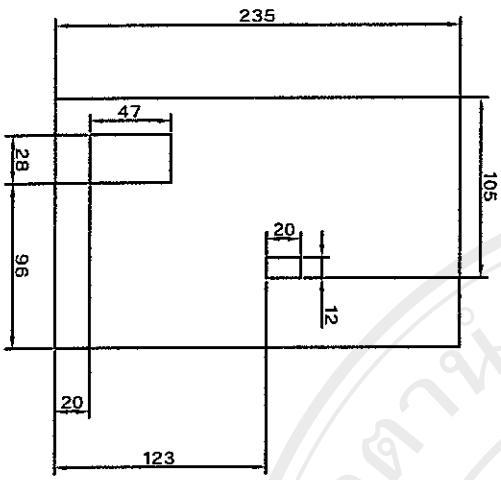
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.254			0.010		
B	1.39		1.65	0.055		0.065
b		0.46			0.018	
b1		0.25			0.010	
D			23.24			0.915
E		8.5			0.335	
e		2.54			0.100	
e3		20.32			0.800	
F			7.1			0.280
I			3.93			0.155
L		3.3			0.130	
Z		1.27	1.59		0.050	0.063

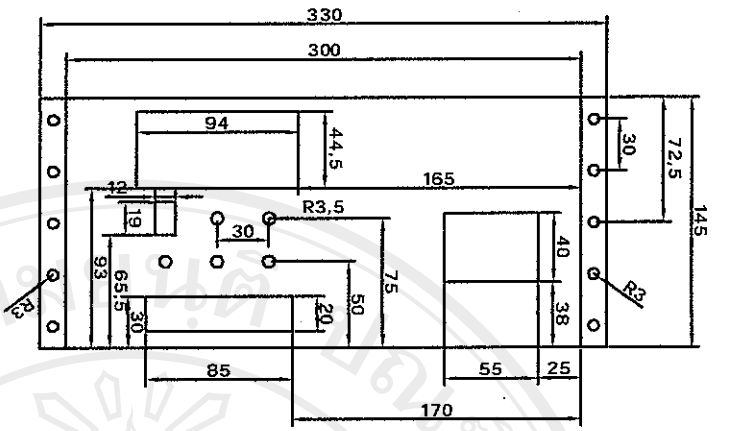
OUTLINE AND MECHANICAL DATA



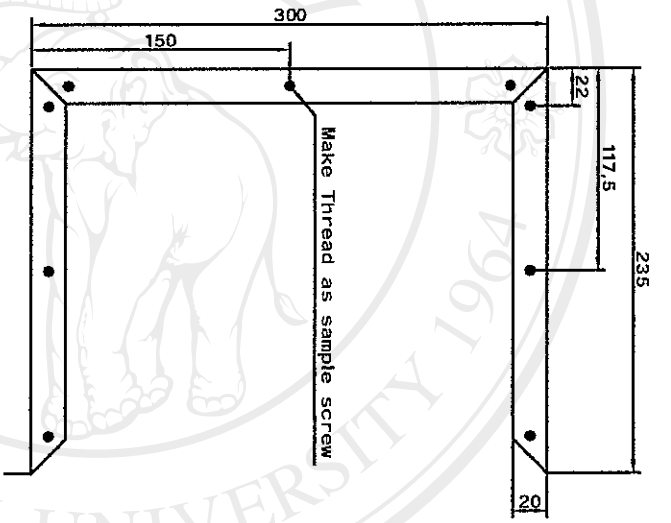
DIP18

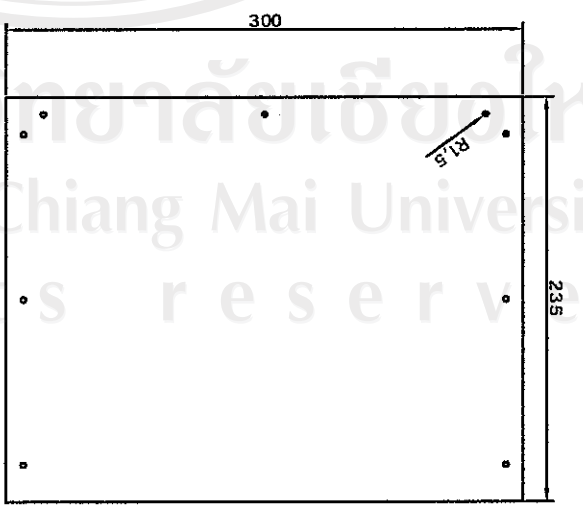


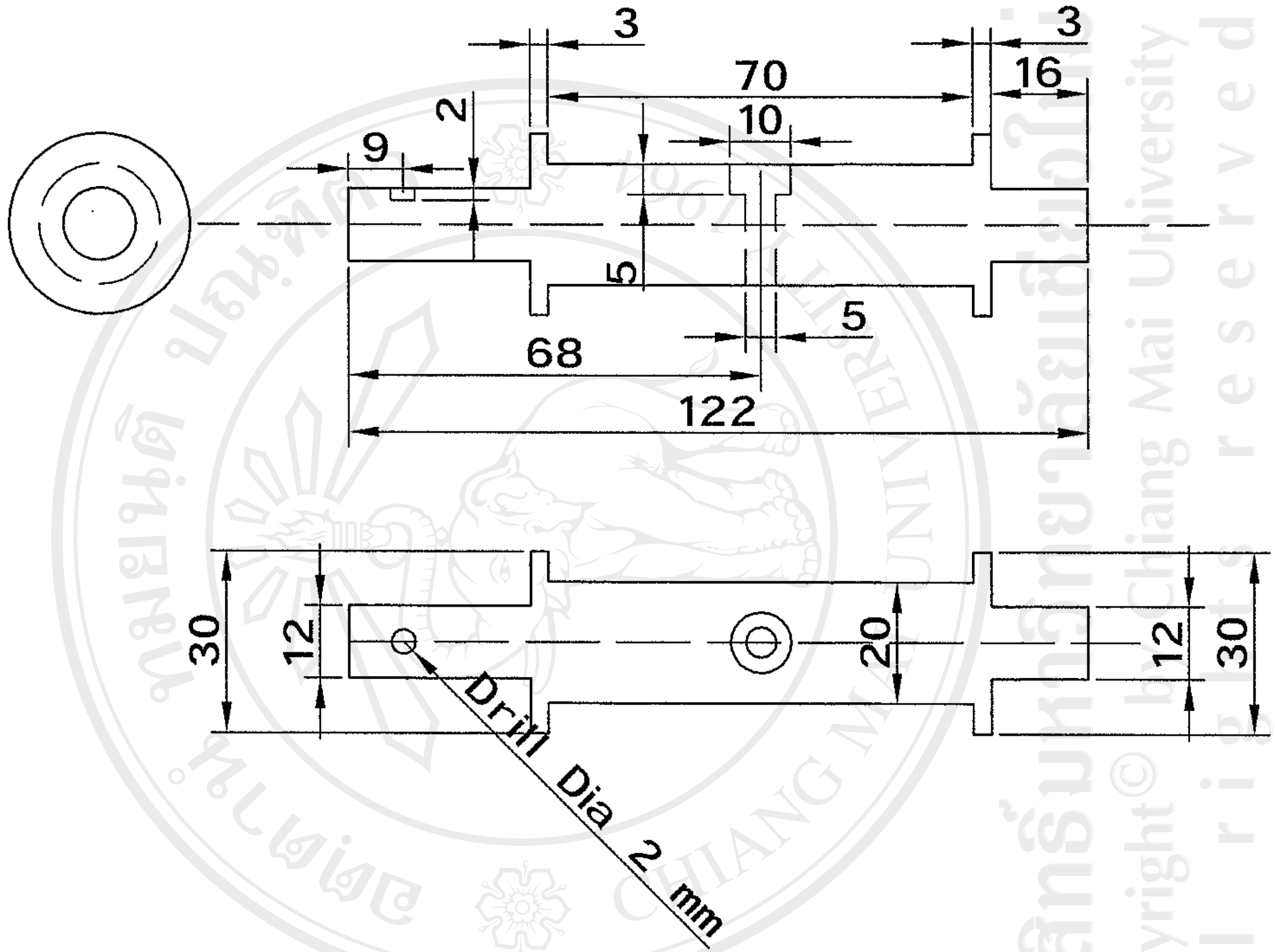




Macning Cover

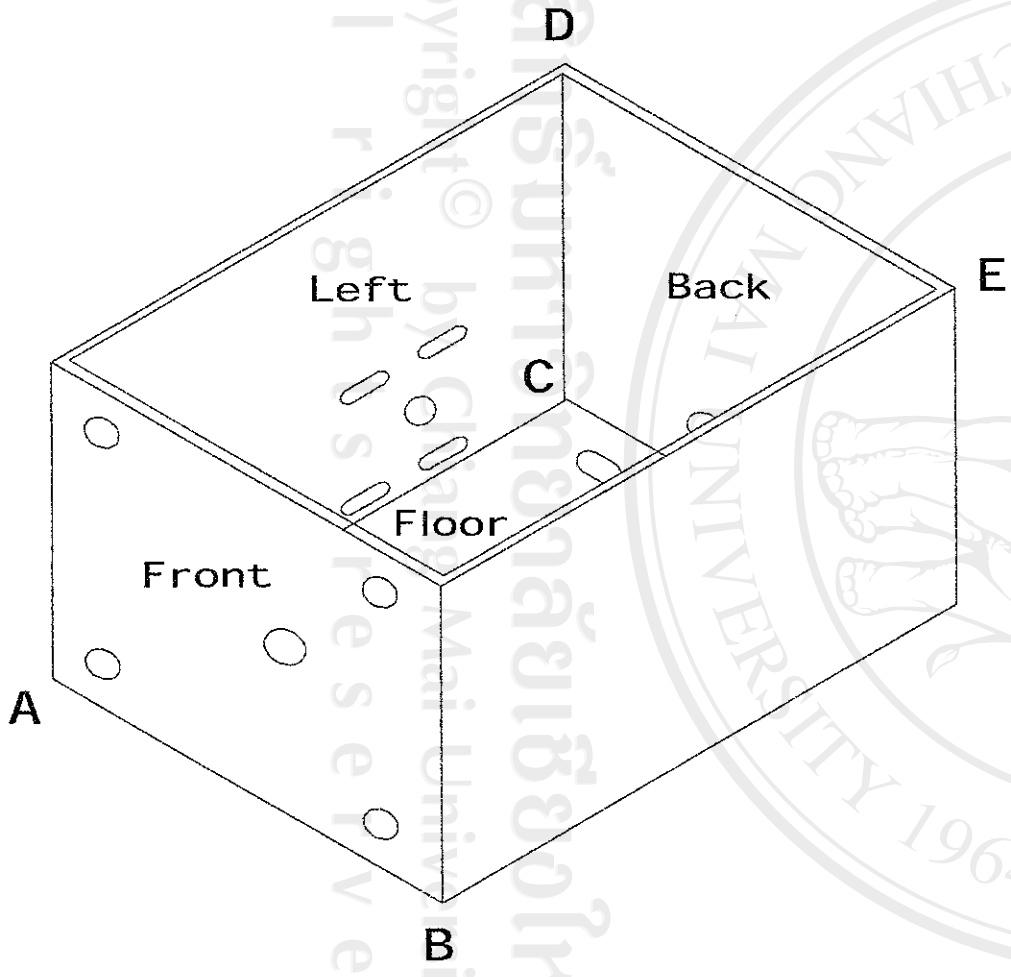


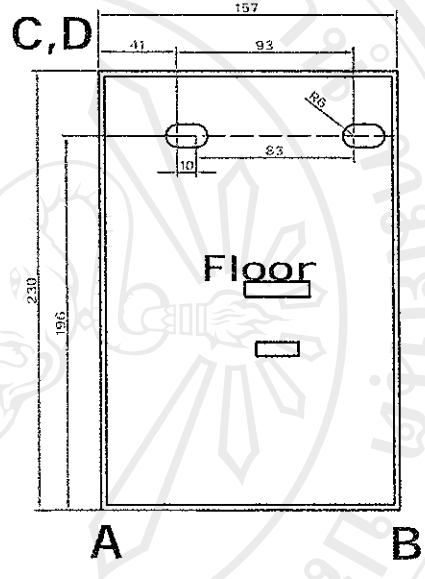


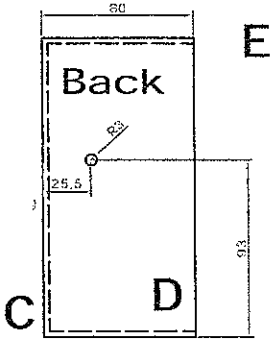


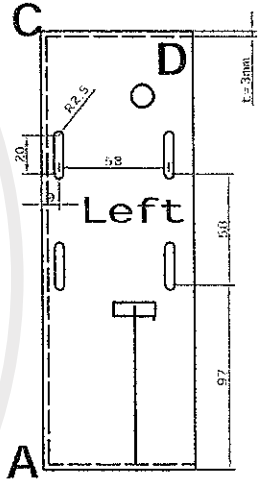
Unit = mm

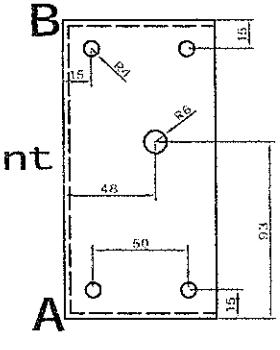
Pull Cylinder







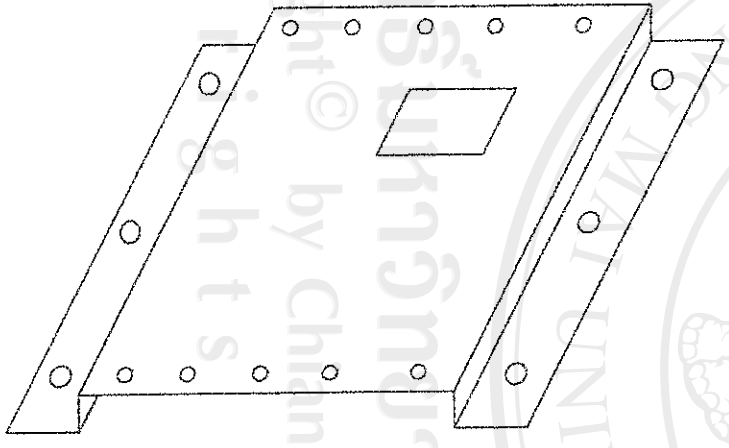


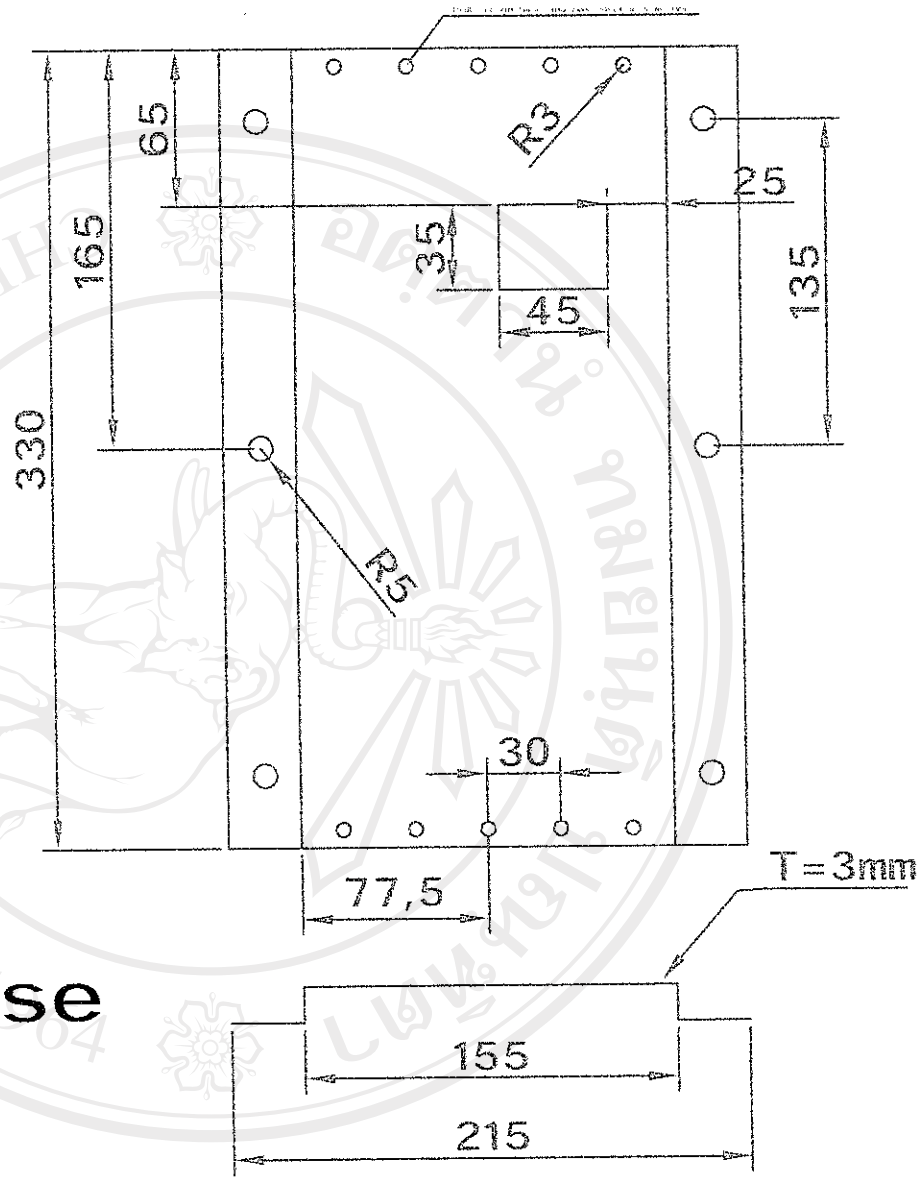


Unit = mm

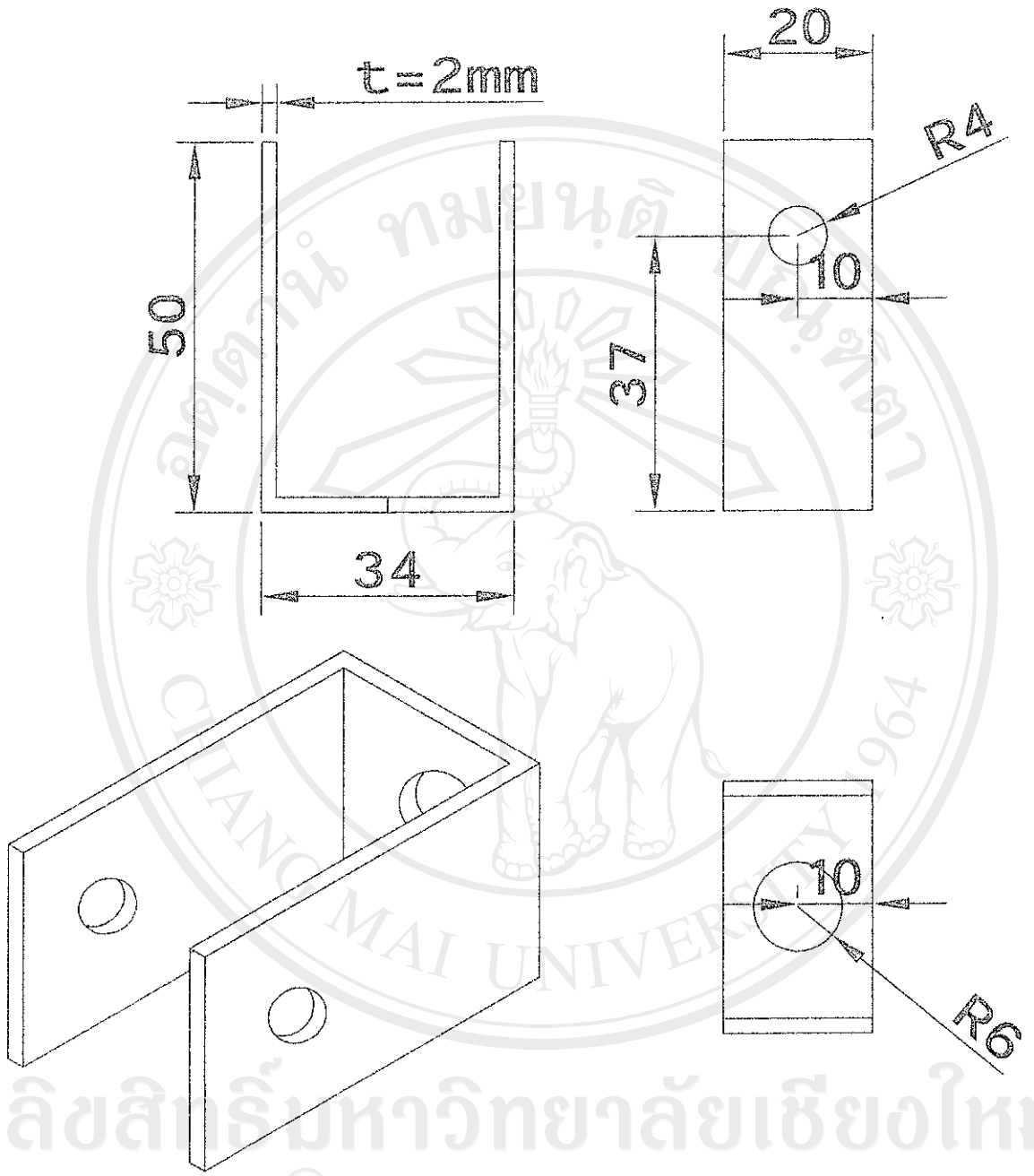
Front

Frame and Gear Box





Machine Base



Unit = mm

Roller Frame