



DynAmp








**Committed
to electro-industrial
process needs**





Our History

For over 40 years, DynAmp has been providing products to capture power conversion & process information needed to safely and efficiently manage electro-industrial processes.

- 1961 -**  Halmar Electronics founded
- 1985 -**  LEM enters high accuracy, high current measurement over 10kA
- 1992 -**  Halmar-Robicon sells Dyn/Amp product line to LEM
- 1995 -**  LEM establishes integrated High Current Systems Business Unit with production in USA and Switzerland
- 1997 -**  LEM HCS announces consolidated product line
- 1999 -**  LEM HCS establishes European “Market Service Center” (MSC)
- 2003 -**  DynAmp is established via LEM supported Management Buy Out of LEM’s High Current Systems business.



Electro-Industrial Processes Served

Process oriented

Aluminum	Primary / Smelting
Chlorine	Electrolysis of Chlorine / Caustic
Copper	Electrolytic refining / Electrowinning
Magnesium	Electrolytic extraction
Steel	Arc furnace
Zinc	Refining
Titanium	Vacuum Arc refining
Nickel	Refining
Manganese	Electrolytic extraction
Fluorine	Production of fluorine gas.
Anodizing	Protective surface on parts
Graphitization	Production from carbon
Electroplating	Deposition of coating, Electrogalvanizing



Non-Process oriented

Large Drives & Inverters	Large AC & DC motor drive control systems.
Furnaces	Induction furnaces
Traction	Trackside power supplies
Welding	DC arc welding
Research	Accelerator, Plasma, Laser...



Customer References

OEM - Providers of power conversion equipment

ABB
Fuji Electric

Areva (Alstom)
Siemens

Friem
Toshiba

ASI (GE Canada, Ansaldo)
BHEL

Mitsubishi

Technology - Providers of the electro-process technology

AI Alcan / Pechiney Alcoa Rusal GAMI ShAMI Kaiser Norsk Hydro/VAW
CI Krupp Uhde Asahi Kasei Denora Eltech Solvey Chlorine Engineers
Zi Umicore Asturianas

Engineering – Large project design and construction


Hatch SNC Lavalin Bechtel Fluor

End User - Owner / operators of the electro-industrial process plants

AI Alcoa / Reynolds Rusal Norsk Hydro/VAW Chalco Albras Indalco Balco
Alcan / Pechiney Sual BHP Billiton CVG Aluar Nalco Hindalco
CI Nexen Olin Carbochloro Kvaerner Solvey
Zi Canadian Zinc Umicore Young-Poong Pasmenco Hindustan Zinc Hudson Bay
Mg US Magnesium AMAG Norsk Hydro



Recent Large Project Examples



Alcan Alma	Canada	400kA	2	2000
Aluminium Pechiney	France	350kA	1	2000
Aluar	Argentina	225kA	2	2000
Tomago Aluminum	Australia	130kA	6	2001
New Zealand Aluminum	New Zealand	225kA	3	2001
Aluminerie Luralco	Canada	400kA	1	2001
Mozal 1 & 2	Mozambique	400kA	4	2002
Alcan	Canada	155kA	1	2002
Hillside	South Africa	400kA	2	2002
Hindalco	India	225kA	2	2003
Hindustan	India	225kA	1	2003
Hydro Sunndal	Norway	300kA	1	2003
Dubal	Dubai	400kA	2	2003
Alumar	Brazil	260kA	1	2003
Hydro Kamoy	Norway	130kA	2	2004
Noranda	USA	225kA	2	2004
Balco	India	350kA	1	2004
Aluminum Becanceour	Canada	300kA	1	2004
Sayanogorsk	Russia	260kA	2	2004
Guizhou	China	260kA	1	2004



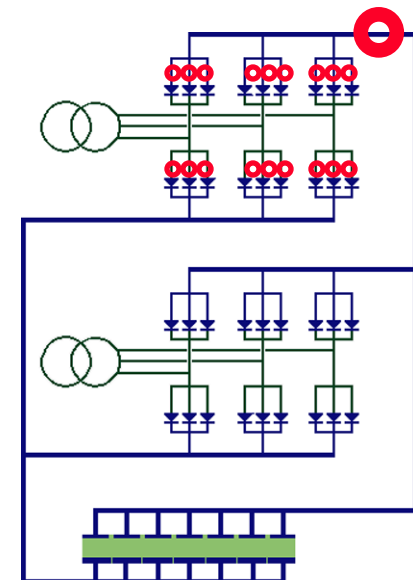
What DynAmp provides

Power Conversion Information

Electrical power must be “converted” from its “delivered” form, to a form usable in the process. This conversion must be measured and controlled to detect losses, ensure stability and protect against over and reverse current events.



- Increase equipment life
- Identify inefficiencies
- Predict maintenance
- Reduce downtime
- Improve process stability





What DynAmp provides

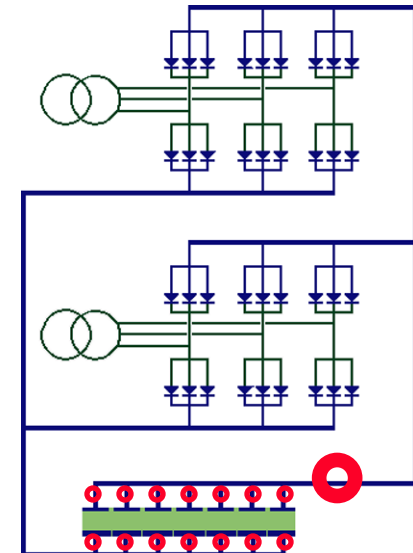
Process Information

Highly accurate measurement of power consumption is a key feedback variable to evaluate and control electro-industrial processes.

“Power is the easiest, most expensive ‘raw material’ to lose.”

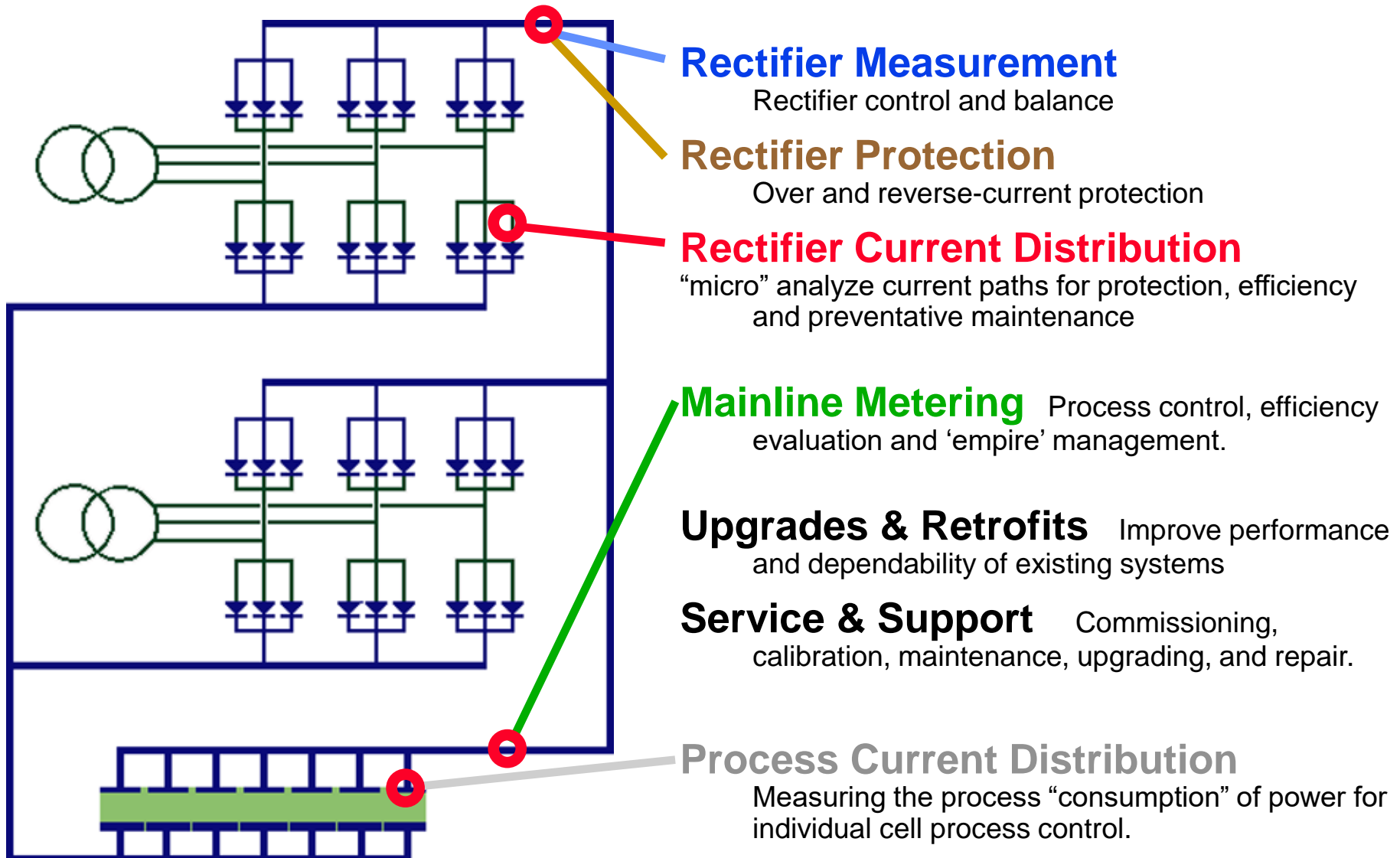


- **For highest Process Controller performance**
- **Fast identification of process problems**
- **Accurate analysis of planned changes**
- **Objective multi-plant management**





DynAmp Product Application Points





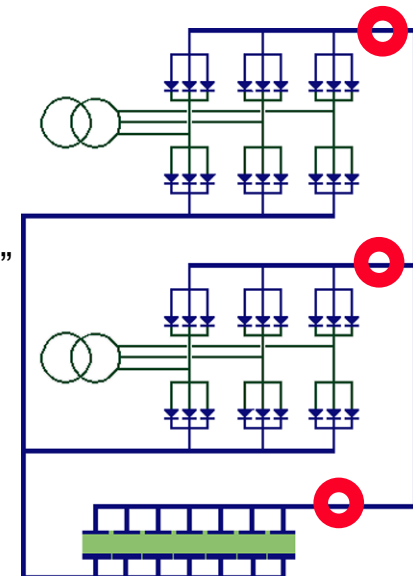
High Accuracy Measurement : LKP



Advanced Multi-Channel Closed-loop Hall Technology

7th Generation High Current Metering Systems

- 0.1% measurement class for accurate process control and efficiency
- Closed loop approach 'locks' calibration for truly objective measurement.
- Systems from 6 to 500kA DC
- Bi-directional systems to 80kA
- The world standard
- Special "Accuracy Diagnostics" monitors accuracy & performance



Picture :350kA Pechiney technology



Optical Current Measurement for HCDC

General Optical Technology Advantages



- **High Accuracy Performance**
- **Compact, modular and lightweight measurement head**
 - Significantly reduced installation cost
 - Can be installed in areas where existing systems won't fit
- **No electromagnetic restrictions regarding mounting location**
 - Superior rejection of external fields and interference
 - Can be mounted on compact bus work





Optical Current Measurement for HCDC

Special Requirements for HCDC :

- **Significantly different measurement head**

*HVAC is relatively low current and uses a significantly smaller conductor
This allows a small, compact head without a part-line. Clearly not acceptable for HCDC.*

HCDC head construction and even the head fiber must be significantly different.



Although optical has experience in HVAC...



... Industrial DC optical experience is minimal.

- **Different opto-electronics performance requirement**

HVAC does not require a true stable zero point, this can be easily calculated based on the waveform

HCDC requires an extremely stable true zero point in order to measure accurately and therefore the opto-electronics must be designed differently



Optical Current Measurement for HCDC

DynAmp Development History :

Understanding Market Requirements

- **Accuracy :**

Existing DynAmp products are proven to maintain high accuracy for 5+ years

- **Proven Dependability :**

Existing DynAmp products are extremely dependable with many systems in use over 30 years.

“Optical must meet or exceed this level of performance, dependability and consistency over the long-term.”



DynAmp's 2nd of 4 generations of optical measurement technology

DynAmp's Optical Technology Development

- DynAmp has been investigating for over 4 years
Evaluating different approaches
via different technical partners
- DynAmp has pursued 4 technical generations
evaluating and validating them
in industrial DC applications

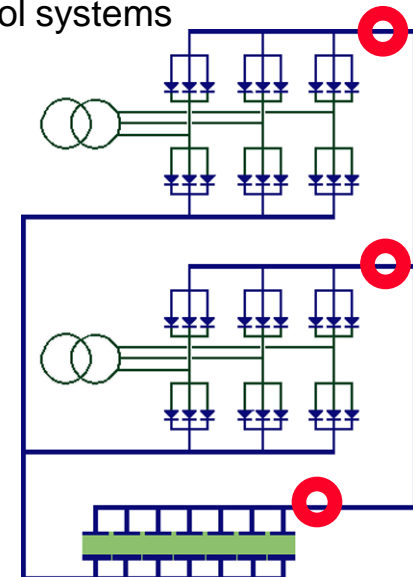


Optical Current Measurement : LKCO

Advanced, Fully Compensated Fiber Optic DC Current Measurement System for Industrial use

Well-proven technology enhanced for DC current measurement application.

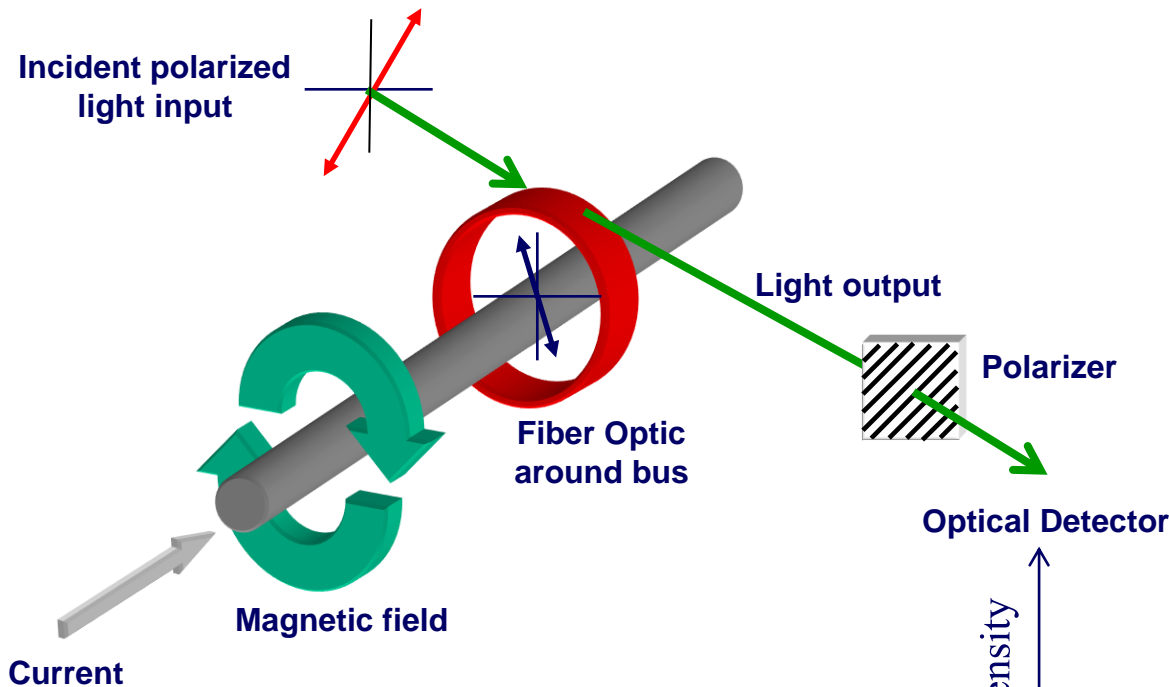
- LKCO represents DynAmp's 4th generation fiber-optic DC current measurement technology
- Unique patented technologies to ensure long term performance
- Exceptionally well proven, military grade optical subsystems
- Designed specifically to interface with both existing and new monitoring and control systems



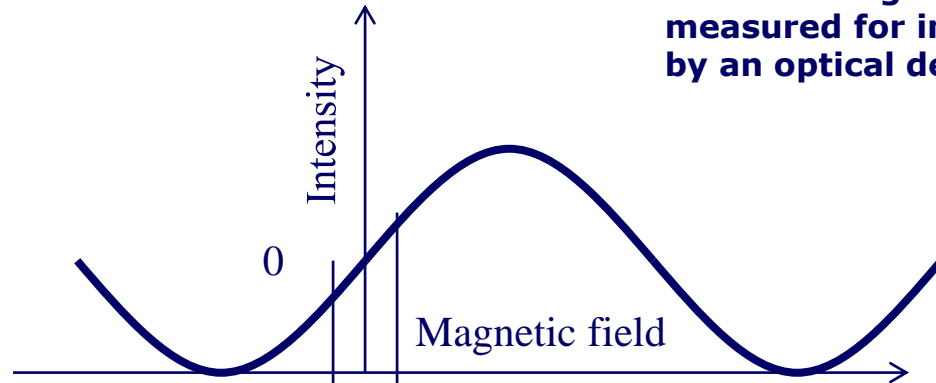


Optical Current Measurement : LKCO

Basic Optical Current Sensor using the Faraday Effect :



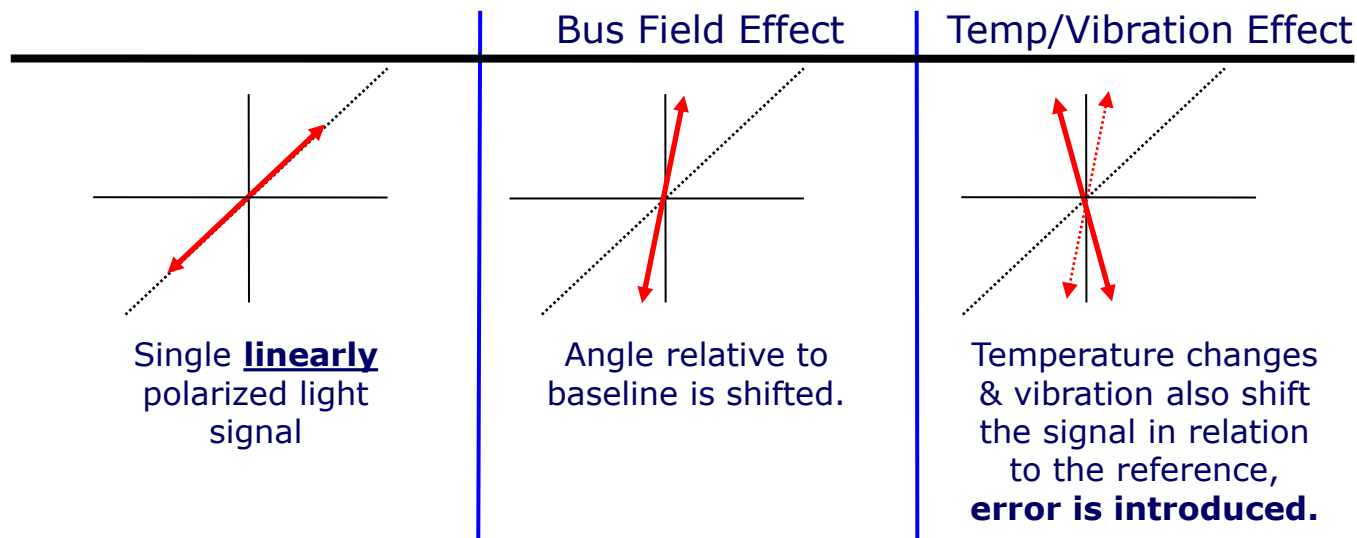
1. Polarized light passes through a magnetic field generated by electrical current
2. The magnetic field shifts the light as a result of the Faraday Effect
3. The shifted light is passed through a Polarizer
4. The resulting light is measured for intensity by an optical detector





Optical Current Measurement : LKCO

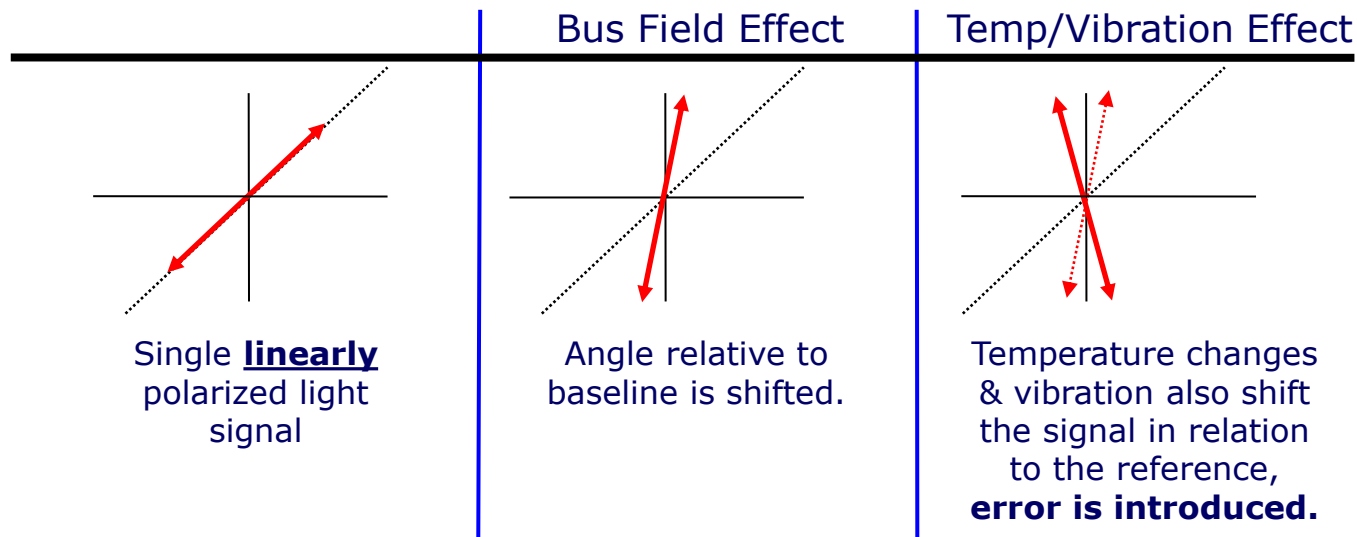
The Original Polarimetric Method :





Optical Current Measurement : LKCO

The Original Polarimetric Method :



A Dual Beam Polarimetric Method was also developed and tested

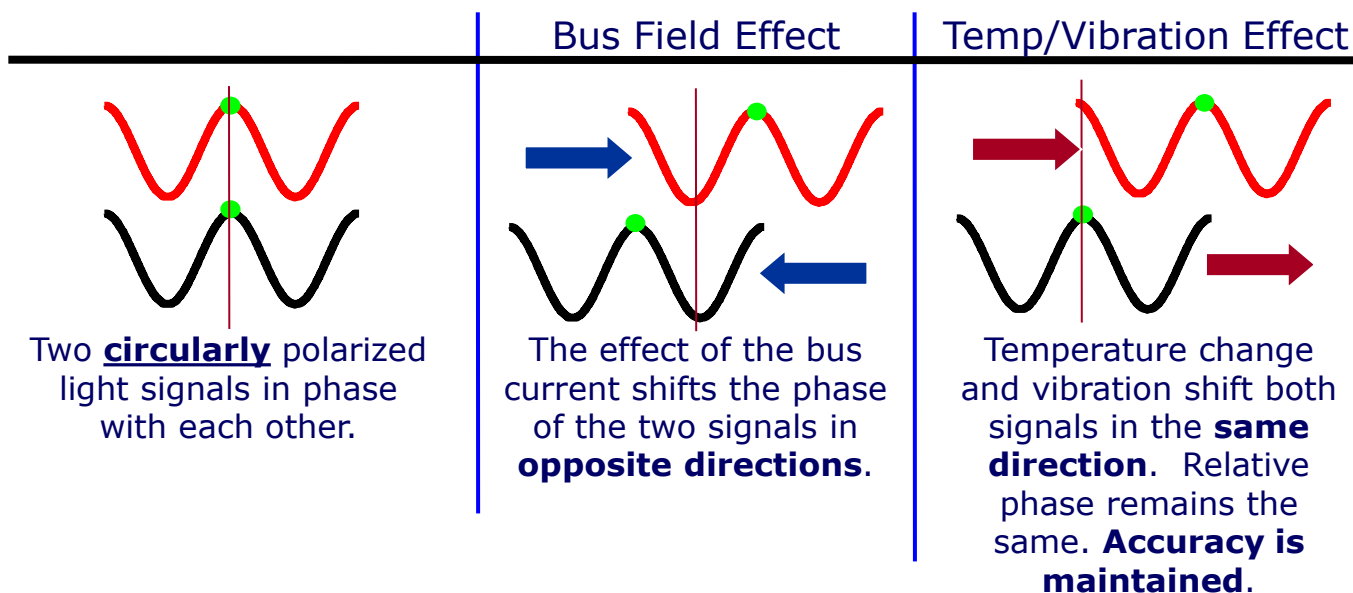
The second linearly polarized light signal was passed through the measurement fiber in the opposite direction. The objective was to use this to cancel the effects of the Temp/Vibration.

While this improved the rejection of these effects dramatically, it was still not good enough for stable long-term performance



Optical Current Measurement : LKCO

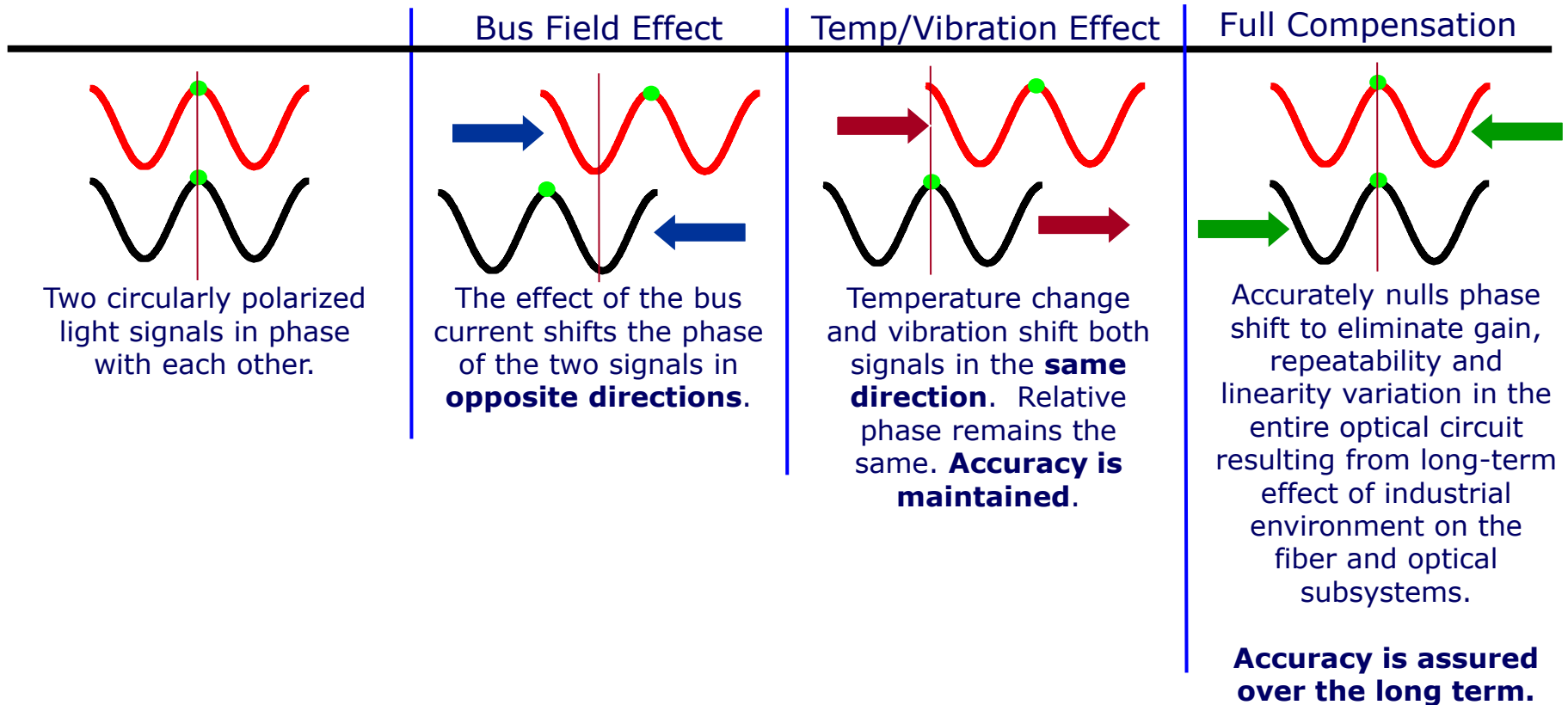
The Basic Interferometric Method :





Optical Current Measurement : LKCO

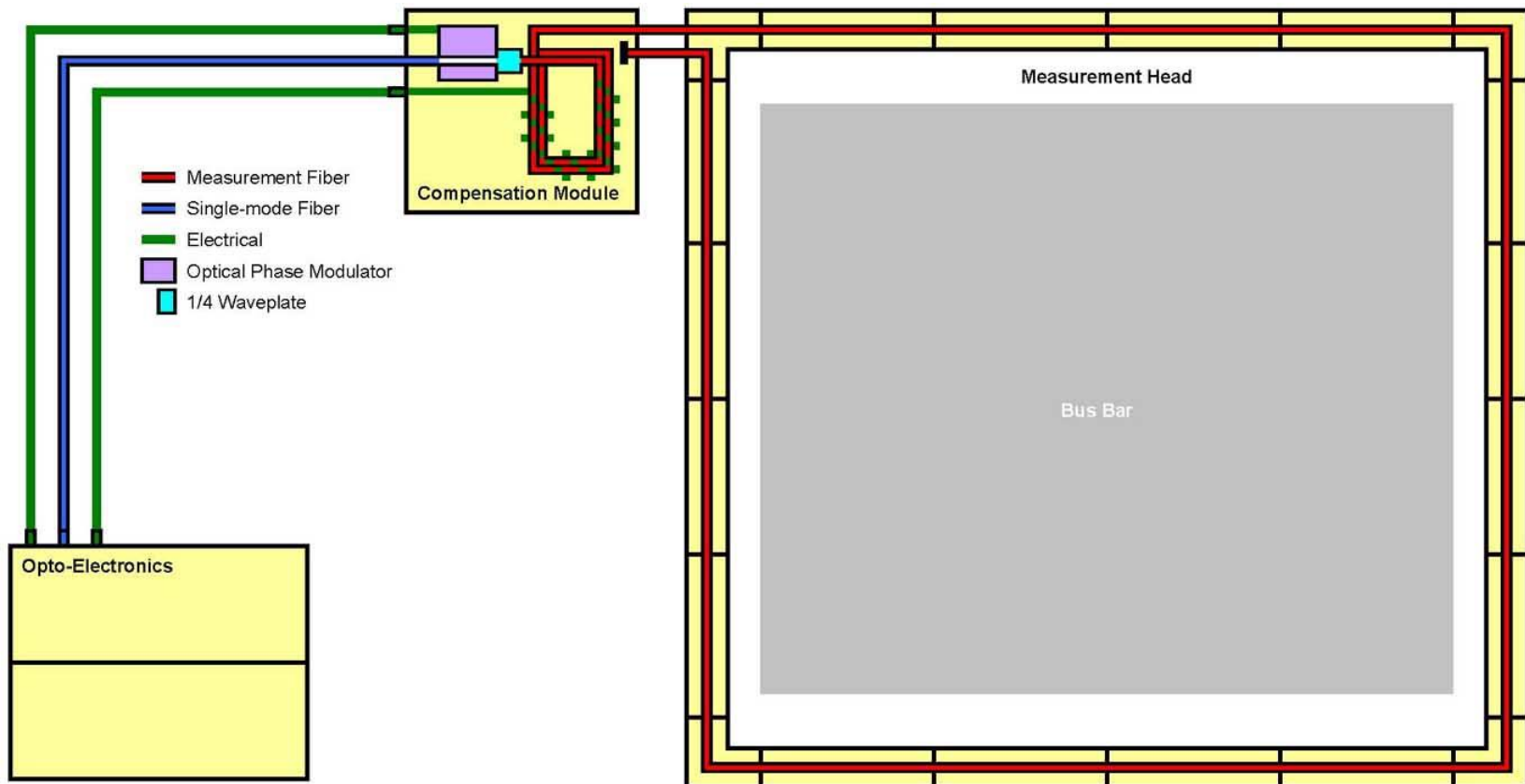
DynAmp's Patented "Full Compensation" Interferometric Method :





Optical Current Measurement : LKCO

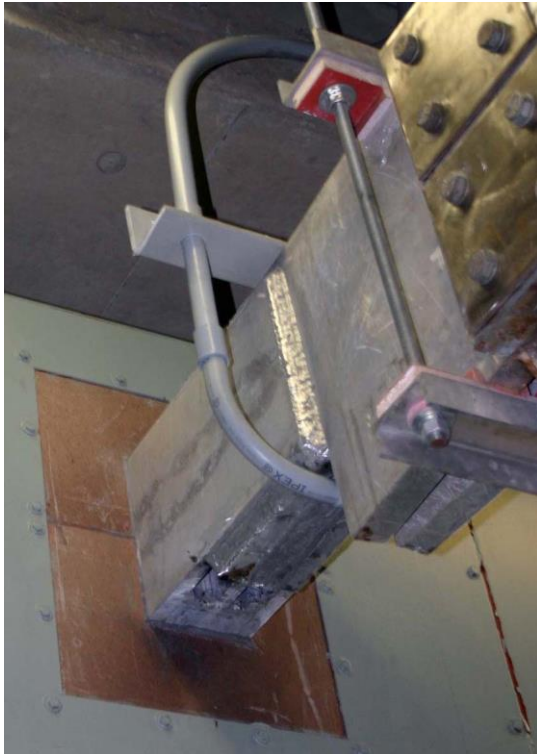
Physical Configuration





Optical Current Measurement : LKCO

General Advantages of Optical Current Measurement Systems :



LKCO 'Beta' unit measurement Head

Beta = Production optics & electronics but not final packaging

True “seamless” integration / sensing of bus magnetic field

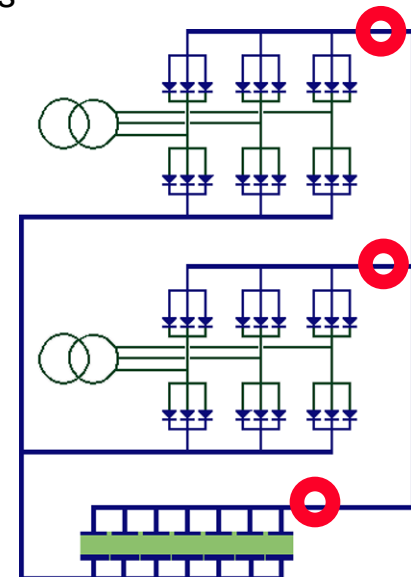
- Unbalanced bus magnetic field does not have any impact on measurement performance
- External fields and interference perfectly rejected
- No Bus Analysis needed to optimize performance
- Superior measurement of low currents

Extremely light weight, modular Measurement Head

- Light-weight construction dramatically reduces shipping, installation costs, and support / protection structures
- Measurement head can be assembled around the bus to accommodate tight installations

Superior Galvanic Isolation

- Measurement sensing elements and head structure are non-conductive





Optical Current Measurement : LKCO

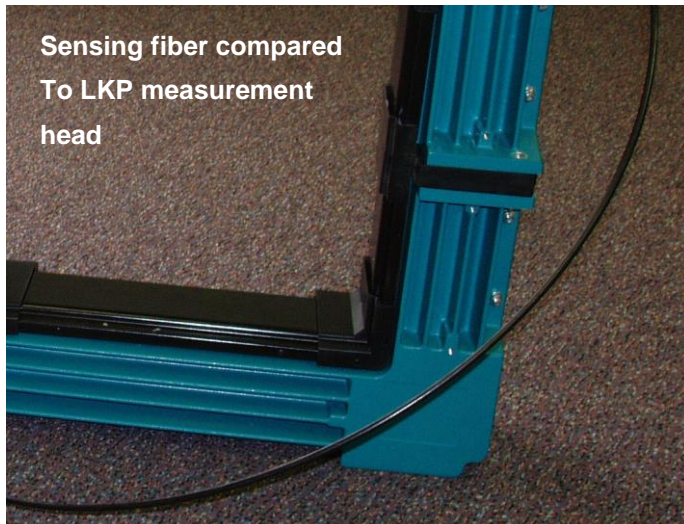
Special Advantages of LKCO :

Patented Full Compensation ensures long-term performance

- minimizes effects of long-term variability of gain, linearity and repeatability

Advanced Accuracy Diagnostics (A²D)

- Continuously monitors system performance for factors that could impact performance. Includes event recording.



Superior, Highly Proven Opto-electronics

- Utilizes actual subsystems proven in military guidance and satellite applications.
- Extremely well proven over wide environmental range
- 100s of millions of hours of actual long-term performance

Plug & Play Replacement of existing systems

- Variety of output signals including industry standard CT ratio current outputs

Experience

- Backed by 40 years of global, high current measurement experience



Optical Current Measurement : LKCO



Product Status :

- 6 LKCOs customer purchased and installed
- 3 additional LKCOs on customer order
- Portable calibration and demonstration system being manufactured
- System being manufactured for short-term customer evaluation

LKCO Specification Summary :

Input : Bus Current to 500 kA full scale
 Over-current 110% measurement
 Infinity without damage, auto-recover

Output : High level current 3mA / kA (333333:1)
 High level voltage 10V full scale
 Low level voltage 1mV / kA
 Frequency (optional) 10kHz fill scale
 Low level current (optional) 20mA full scale
 Digital (optional) to customer specification
 Display (optional) in electronics enclosure

Measurement accuracy ± 0.1% or better
 Repeatability ± 0.01% of FS or better
 Linearity ± 0.1% of FS or better

Mains AC 95 to 265 VAC RMS @ 47 to 62Hz
 DC 110 to 250 VDC

	<u>Head / Comp.</u>	<u>Opto-Electronics</u>
Environmental	IP65	IP32
Operating Temp.	-30° to 60°C	-10° to 40°C
Storage Temp.	-30° to 60°C	-10° to 40°C

Physical

Measurement Head :	Sized to bus (10cm x 10 cross-sec)
Compensation Module	50cm w x 15 h x 50 d
Opto-electronics	50cm w x 40 h x 50 d

Connection Mains & Signal out screw terminals
 Head to Comp. Module electrical and fiber optic
 (optical connector at opto-electronics enclosure)



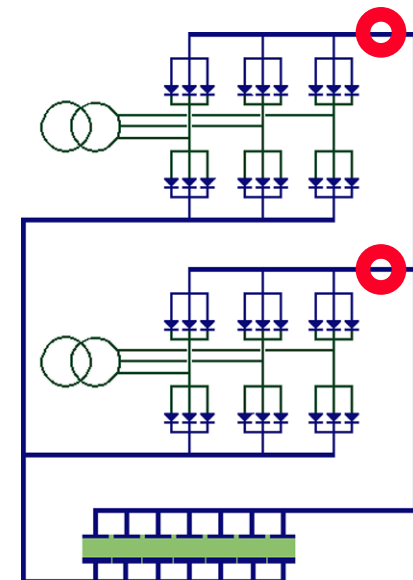
Measurement & Protection : LKAT

Superior Rectifier Measurement & Protection in one compact system

New approach to DC measurement and rectifier protection.

- 0.75% control-class performance
- Includes Accuracy Diagnostics for measurement confidence
- Includes reverse current protection relay
- IP67 construction for installation in harsh environments
- Optional protection extensions for additional outputs and alarms
- Optional display for local readout

“Extremely cost-effective, multi-function system for rectifiers”





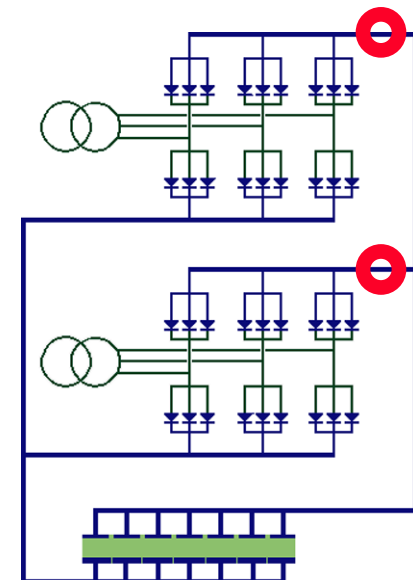
Measurement & Protection : LKAT

Based on DynAmp developed “Open Loop Open Path” Technology

Unique LKAT Benefits.

- Extremely compact design for flexible and low-cost installation
- Bus hugging design further minimizes external field influence
- Cost is driven by head size, not current. Small bus = low cost
- Industry standard 20mA output can still be totalized if desired
- Immune to over-current damage
- Industrially proven technology

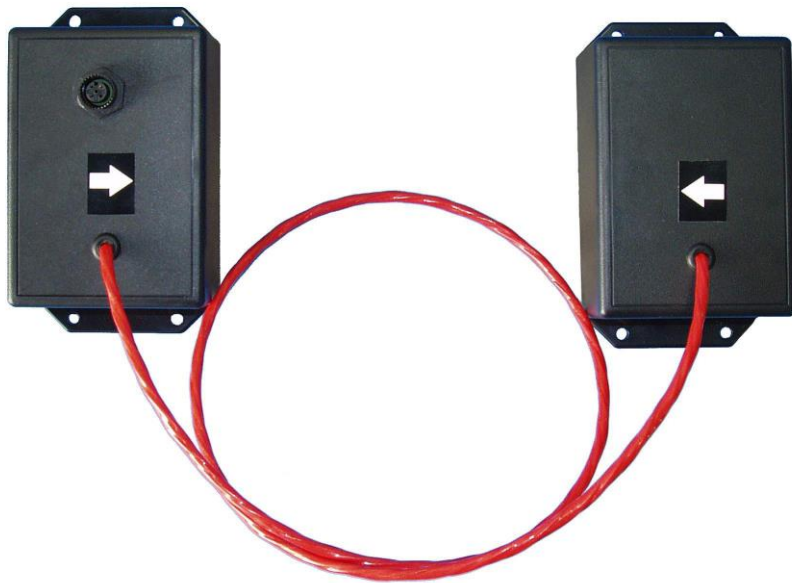
“All available at approximately half the cost of LKP”





Rectifier Protection : BRP

Highly Reliable Advanced Sensing with Modular Functionality

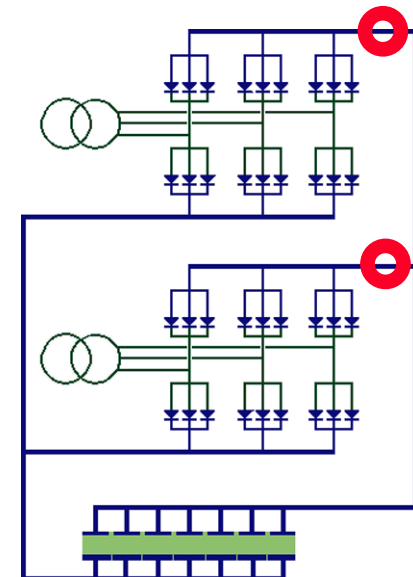


Basic Rectifier Protection Sensor Pair :

- Special integrated ASIC sensor with on-board temperature compensation and signal amplification
- New proprietary DynAmp magnetic shielding to minimize influence of external fields dramatically reducing the chance of false trips.
- Fail-safe reverse-current alarm output signal

Available Auxiliary Electronics adds :

- Solid State and Mechanical Relays for direct actuation of protection systems and equipment
- Accuracy Diagnostics for performance confidence
- Latching local indication of alarms with manual reset



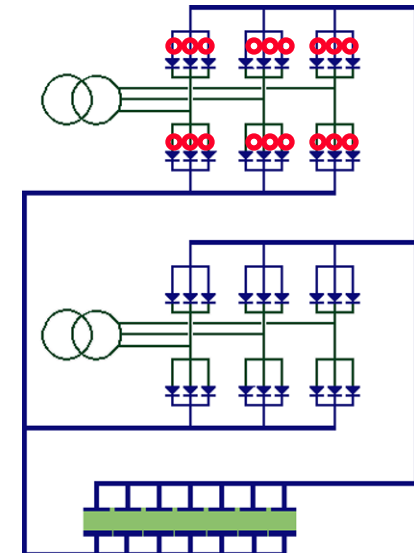
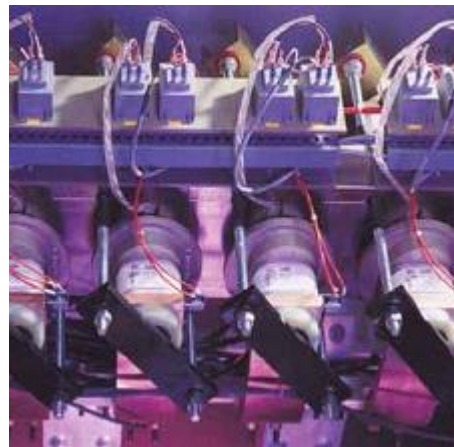
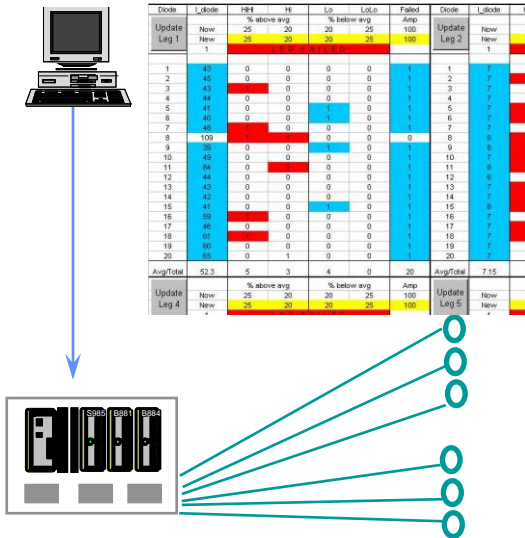


Power Conversion Instruments : RCEM

Rectifier "Health" Monitoring

Monitor rectifiers for inter-device and inter-leg balance to identify potential problems, manage maintenance and exploit N-1 designs for additional current

- Up to 240 input channels to monitor each semiconductor
- Computer display software
- Permanent and portable versions
- USB as well as industrial data bus communication available
- Excellent diagnostic and preventative maintenance tool

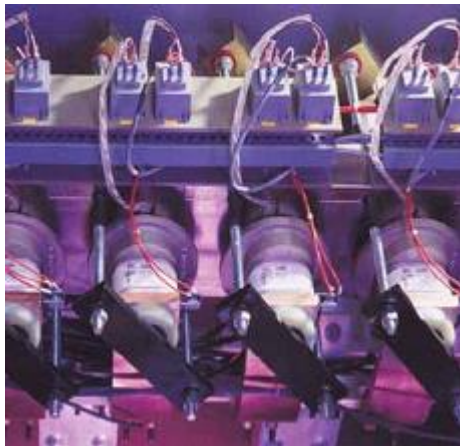
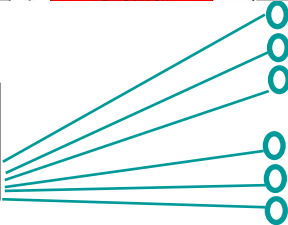




Power Conversion Instruments : RCEM



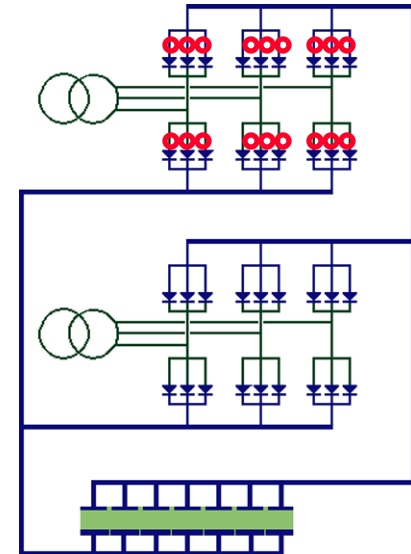
Code	Lcode	Hrd	H	Lo	L.O.C	Failed	Code	Lcode	H
Update	Now	25	20	20	25	100	Update	Now	2
Lag 1	Now	25	20	20	25	100	Lag 2	Now	2
1	1						1	1	
1	45	0	0	0	0		1	45	
2	45	0	0	0	0		2	45	
3	44	0	0	0	0		3	44	
4	45	0	0	0	0		4	45	
5	40	0	0	0	0		5	40	
6	46	0	0	0	0		6	46	
7	100	0	0	0	0		7	100	
8	28	0	0	0	0		8	28	
9	49	0	0	0	0		9	49	
10	96	0	0	0	0		10	96	
11	44	0	0	0	0		11	44	
12	45	0	0	0	0		12	45	
13	45	0	0	0	0		13	45	
14	45	0	0	0	0		14	45	
15	41	0	0	0	0		15	41	
16	99	0	0	0	0		16	99	
17	97	0	0	0	0		17	97	
18	97	0	0	0	0		18	97	
19	90	0	0	0	0		19	90	
20	85	0	1	0	0		20	85	
AugTotal	52.3	5	3	4	0	20	AugTotal	7.15	1
Update	Now	% above avg	% below avg	Amp			Update	Now	
Lag 4	Now	25	20	20	25	100	Lag 5	Now	2
Lag 4	Now	25	20	20	25	100	Lag 5	Now	2



Using RCEM to improve reliability

Perform preventative rectifier maintenance based on “actual condition” to minimize failure and downtime !

- 1) Periodically RCEM analyze current balance between individual semiconductor/fuse paths in each leg as well as current balance between legs.
- 2) If analysis shows developing trend or more sudden shift in current balance (some semiconductor/fuse paths carrying significantly more current than other paths) schedule maintenance as needed to clean surfaces and test semiconductors and fuses.
- 3) After maintenance and corrective actions are completed, RCEM analyze the rectifier again to confirm improvement

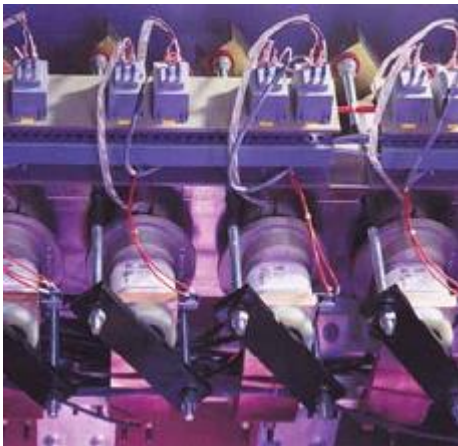
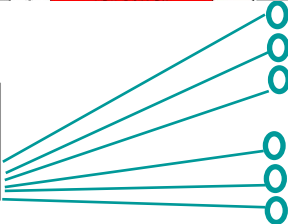




Power Conversion Instruments : RCEM



Diode	Label	H	L	L.O.C	Failed	Diode	Label	H
Update	Now	25	20	20	100	Update	Now	2
Lag 1	Now	25	20	20	100	Lag 2	Now	1
1	45	0	0	0	0	1	45	0
2	45	0	0	0	0	2	45	0
3	44	0	0	0	0	3	44	0
4	44	0	0	0	0	4	44	0
5	45	0	0	0	0	5	45	0
6	40	0	0	0	0	6	40	0
7	46	0	0	0	0	7	46	0
8	100	0	0	0	0	8	100	0
9	28	0	0	0	0	9	28	0
10	49	0	0	0	0	10	49	0
11	96	0	0	0	0	11	96	0
12	44	0	0	0	0	12	44	0
13	45	0	0	0	0	13	45	0
14	45	0	0	0	0	14	45	0
15	41	0	0	0	0	15	41	0
16	99	0	0	0	0	16	99	0
17	96	0	0	0	0	17	96	0
18	97	0	0	0	0	18	97	0
19	90	0	0	0	0	19	90	0
20	85	0	1	0	0	20	85	0
Aug/Total	52.3	5	3	4	20	Aug/Total	7.15	1
Update	Now	% above avg	% below avg	Amp	Update	Now		
Lag 4	Now	25	20	20	25	Lag 5	Now	2
		25	20	20	25			2

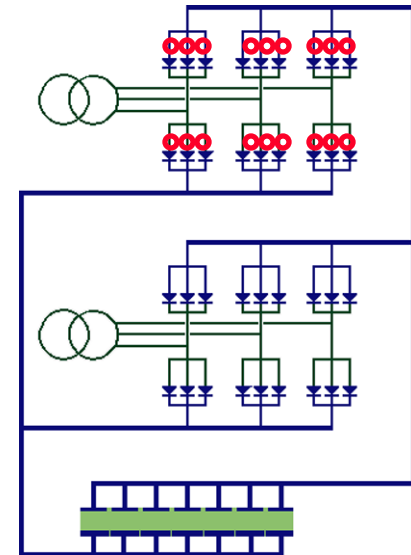


Using RCEM to increase output

Supports exploitation of internal n-1 or n-2 designs to achieve higher current outputs

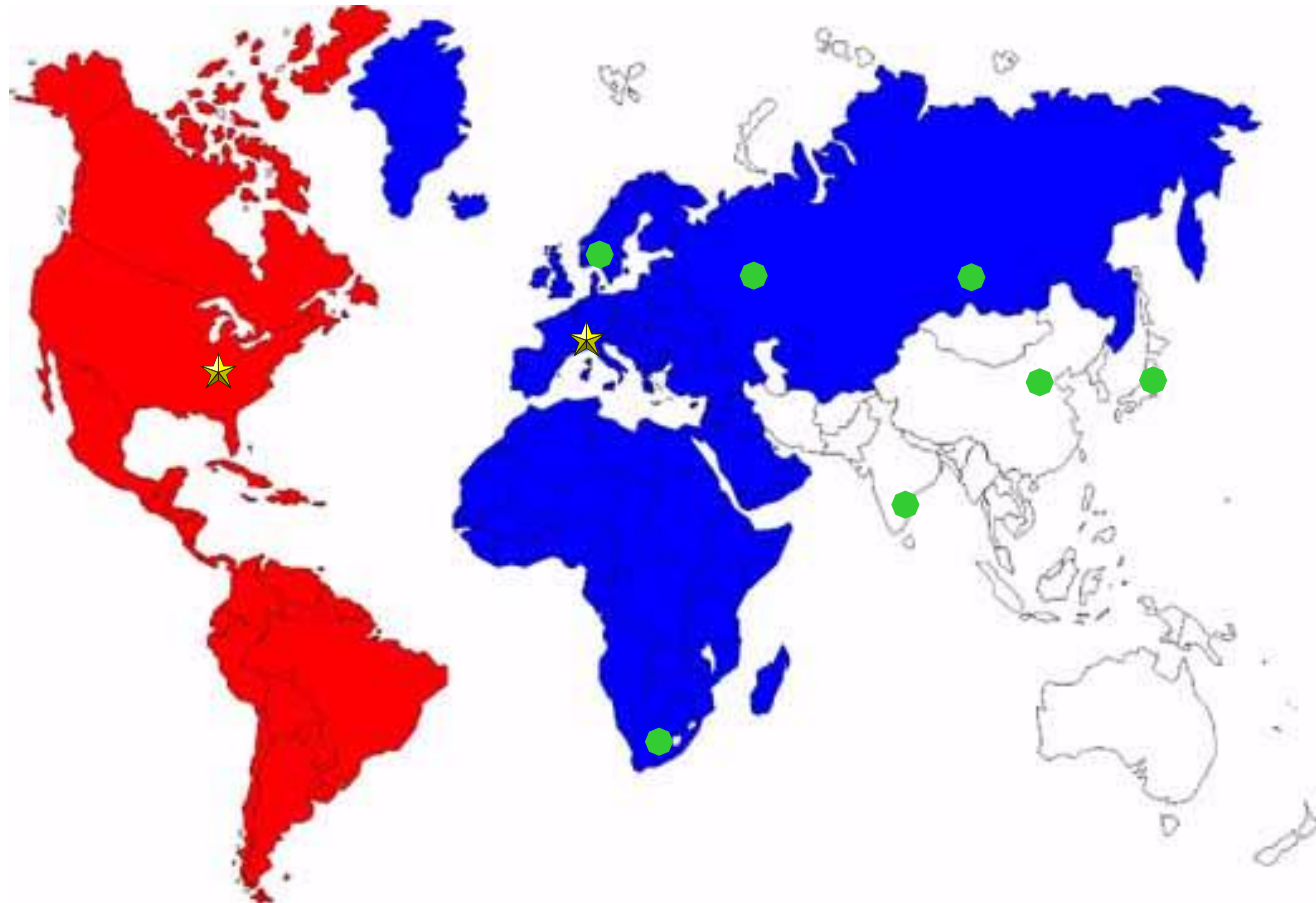
- 1) Measure the real RMS current levels of individual semiconductor/fuse paths using RCEM
- 2) Compare against the semiconductor/fuse specification limits.
- 3) Incrementally increase current using RCEM to monitor both balance and maximum currents while increasing current towards semi-conductor/fuse limits.
- 4) Set alarm levels in RCEM and continue to monitor for a period of time to evaluate current balance stability adjusting total current as needed
- 5) If stability is established, remove RCEM but periodically re-analyze current balance and maximums.

NOTE : n-1 or n-2 designs should never be exploited without automatic fuse condition monitoring including automatic rectifier control action





Global Support



Headquarters & Factory :
Columbus, Ohio, USA

★ **Market Service Centers**
*100% DynAmp team
dedicated to support
customer and regional
sales partners*

- **America / Asia :**
Ohio, USA
- **Euro/Africa :**
Geneva, Switzerland

- **High capability partners**
 - *Norway*
 - *South Africa*
 - *Russia (in training)*
 - *India*
 - *China*
 - *Japan*



Support Services

Highly skilled, objective support for your equipment and systems



In-factory as well as on-site

- Calibration
- Installation and Commissioning
- Select rental equipment
- Plant Equipment Surveys
- Supplemental Bus Analysis
- Upgrade installation and verification
- Repair



“ ... your on-call resource ! “



DynAmp.com

Find a wealth of information on our updated website !

- *Application Overviews*
- *Product Line Overviews*
- *Detailed Product Datasheets*
- *Product Worksheets*
- *Users Manuals*
- *Technical Bulletins*
- *Service Bulletins*
- *Industry Links*
- *Company News*



Electro-Process and High Power Conversion
Measurement, Control & Protection



Welcome to DynAmp

formerly LEM DynAmp / High Current Systems.

For over 40 years DynAmp has been the recognized global leader in providing high power conversion and consumption measurement solutions. The unique knowledge we have gained allows us to apply "real world know-how" and advanced technology to provide the most advanced, reliable high power measurement and analysis systems available. Whether the application requires measurement of a single high current bus, rectifier monitoring, or a complete multi-port process monitoring system DynAmp can provide the solution.

- DynAmp Home
- Business Concept
- Company Profile
- Company History
- Company News
- Industry Links
- Applications
- Products & Services
- Contact Us / Support



Applications :

The need for electrically intensive applications to...

- increase process efficiency,
- objectively compare different process lines and multiple locations,
- provide accurate information to control equipment,

Over 40 years of experience has provided DynAmp with a... and services specifically designed for a variety of electro-c...

Contact and Support :



For detailed information, we offer the following additional resources:

- Application Overviews**: Overviews of how our products are used in a variety of applications
- Product Documentation**: Datasheets, Users Manuals and Ordering Worksheets
- Technical Bulletins**: Additional technical information about the use of our products
- Market Bulletins**: Additional background information about the applications and markets in which

Factory Support / Americas: DynAmp maintains two regional factory offices to provide direct customer support.
 8am to 5pm US Eastern Time (Nov-Apr: 1300 to 2200 GMT / May-Oct: 12001
 Tel: (+1) 614-871-8900 Fax: (+1) 614-871-6910

Europe: 8:30am to 5pm Central European Time (Nov-Apr: 0730 to 1600 GMT / May-Oct
 Tel: (+41) 22 706 1445 Fax: (+41) 22 706 1311

Service Emergency: (+1) 614-871-6966
Central e-Mail: help@dynamp.com

Global Support Partners: In addition, DynAmp has a number of skilled regional partners to pro...

Products & Services : LKP

Based on over 40 years of know-how and expertise, DynAmp LKP systems are the most accurate and proven DC current measurement systems available for electro-industrial applications. With 0.1% accuracy performance at current ranges up to 500kA, LKP systems simply have no equal. DynAmp offers both LKP unidirectional/DC measurement systems as well as LKB bi-directional/AC current measurement systems

- 0.1% accuracy class measurement up to 500kA
- Non-contact design for installation ease and safety
- Multi-channel, closed-loop hall-effect technology for superior performance in adverse magnetic, environmental and industrial conditions over the long term.
- Extremely stable and responsive measurement for superior control performance
- Split-head design for easy installation, eliminates bus bar cutting
- Cast Aluminum construction for durability
- Extremely robust electronics for reliability and long life.
- Included DynAmp Bus Analysis to ensure highest performance and accuracy in your specific application
- Available Accuracy Diagnostics continuously monitors system operation to immediately signal customers of operating conditions which could compromise accuracy or performance
- Available totalizing equipment sums multiple LKP system measurements while maintaining high accuracy



Special Note Regarding Rectifier Control: By measuring the actual DC output of the rectifier, the control loop is dramatically shortened for superior responsiveness as compared to other, "more remote" measurement points such as ACCT measurement on the primary side or "measurement" windings within the rectifier transformer. Using the actual DC output of the rectifier as the control input eliminates the effects of changes in rectifier / transformer efficiency, dynamics between multiple transformer secondaries and phase un-balance on the control of the rectifier.

System Series Documentation

- | Title | Title | Publication # | Modified |
|----------------------|-------|---------------|----------|
| ▶ Data Sheets | | | |
| ▶ Manuals | | | |
| ▶ Product Worksheets | | | |



DynAmp

High Current Systems

At
Your
Service

