

Numerical Protective and Management Relays

Presented at:

The Institution of Engineers (India)
Andaman and Nicobar State Centre
Port Blair

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December 2006

SELF-PROTECTION BY HUMAN BEING AGAINST AN IMPENDING DANGER

Danger!



1. Eyes see the fire

2. Ears hear the blast

3. Signals from eyes
and ears go to brain

4. Signal
from brain
goes to
legs

5. Action

Run away



POWER SYSTEM EQUIPMENT THAT NEED PROTECTION

- Generators
- Transformers
- Bus Bars
- Feeders
- Large Motors
- Other Equipment

GENERATORS NEED PROTECTION



TRANSFORMERS NEED PROTECTION



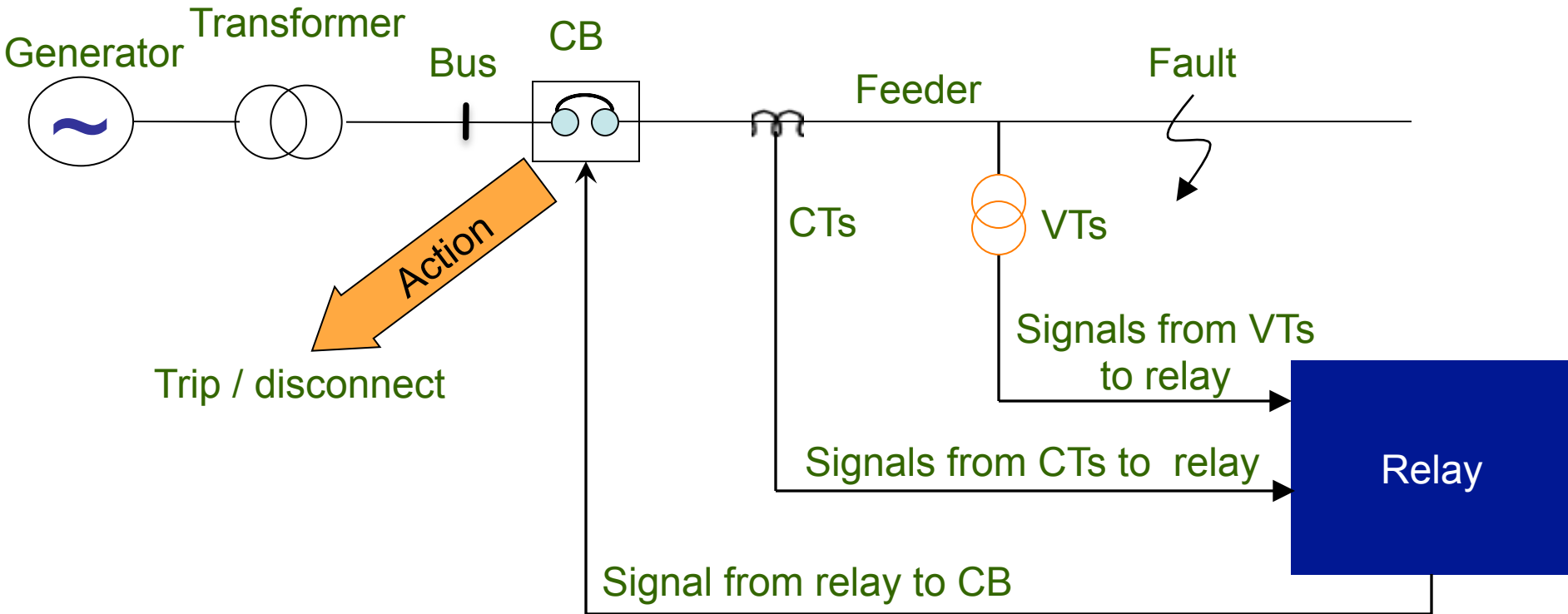
BUS-BARS NEED PROTECTION



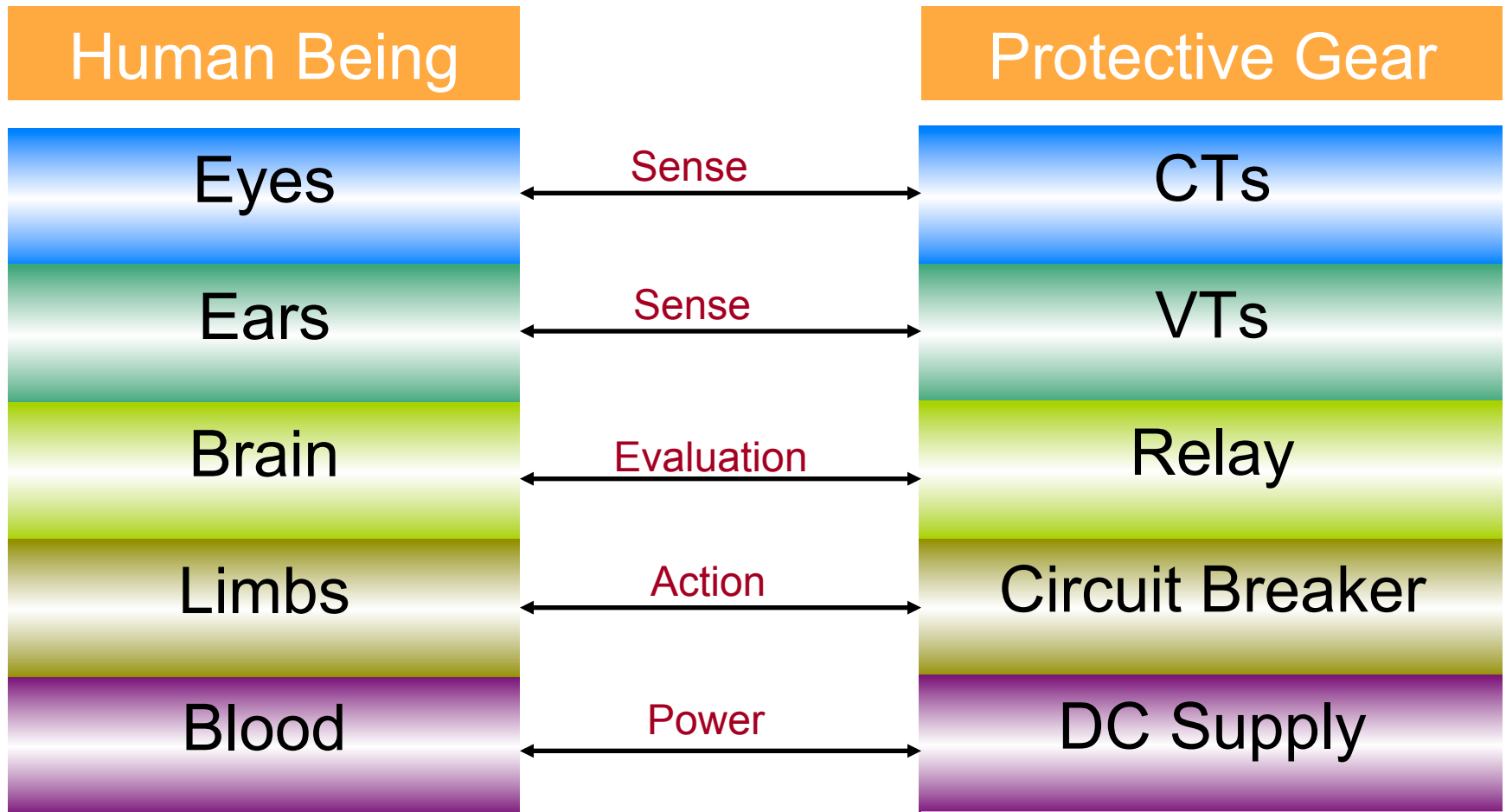
FEEDERS NEED PROTECTION



PROTECTION OF FEEDER BY PROTECTIVE GEAR



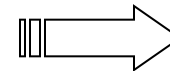
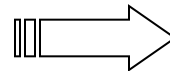
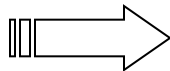
THE TWO PROTECTION SYSTEMS



QUANTITIES MEASURED BY RELAYS

Quantity	Relay
Current magnitude	O/C relay
Voltage	O/V and U/V relays
Current difference	Differential relay
Voltage / current ratio	Distance relay
Voltage x current product	Power relay
Current direction and magnitude	Directional O/C relay
Power direction and magnitude	Reverse power relay
Current unbalance	Negative sequence relay
Other quantities	Other relays

4 GENERATIONS OF PROTECTIVE RELAYS



I Generation

Electromagnetic &
bimetallic
relays

II Generation

Hard-wired
static or
electronic
relays

III Generation

Digital,
 μ P-based
or numerical
protective
relays

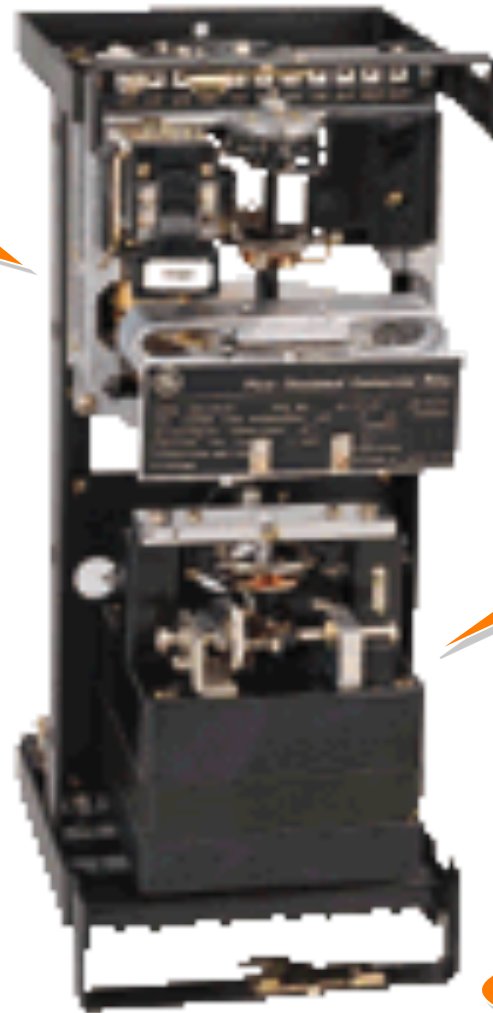
IV Generation

Numerical
multifunction
& management
relays

FIRST GENERATION RELAYS : AN EXAMPLE

Electromagnetic principle & device

EM directional overcurrent relay from GE



Mechanical contacts

Moving parts

Source : <http://www.GEmultilin.com>

SECOND GENERATION RELAYS: AN EXAMPLE

Electronic circuits & devices

Reed contact/
thyristor/
transistor
output

Static negative sequence relay
from GE



Source : <http://www.GEmultilin.com>

No moving parts

THIRD GENERATION RELAYS: AN EXAMPLE

Microprocessor inside

Reed contact/
thyristor/
transistor
output

Numerical
overcurrent and
earth-fault relay
from ABB



Source: <http://www.abb.com/>

All static parts

Single function
only

FOURTH GENERATION RELAYS: AN EXAMPLE

Microprocessor
inside

Reed
contact/
thyristor/
transistor
output

489
Generator Management Relay

 GE Multilin

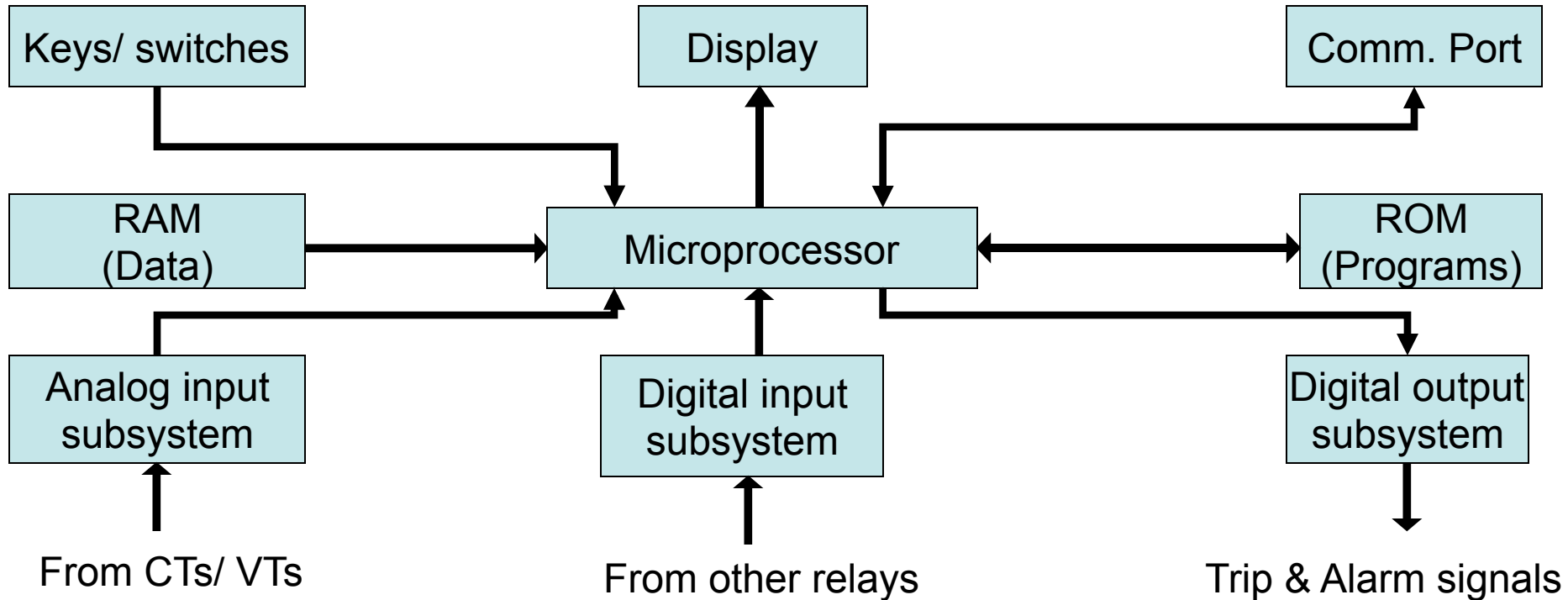


Source : <http://www.GEmultilin.com>

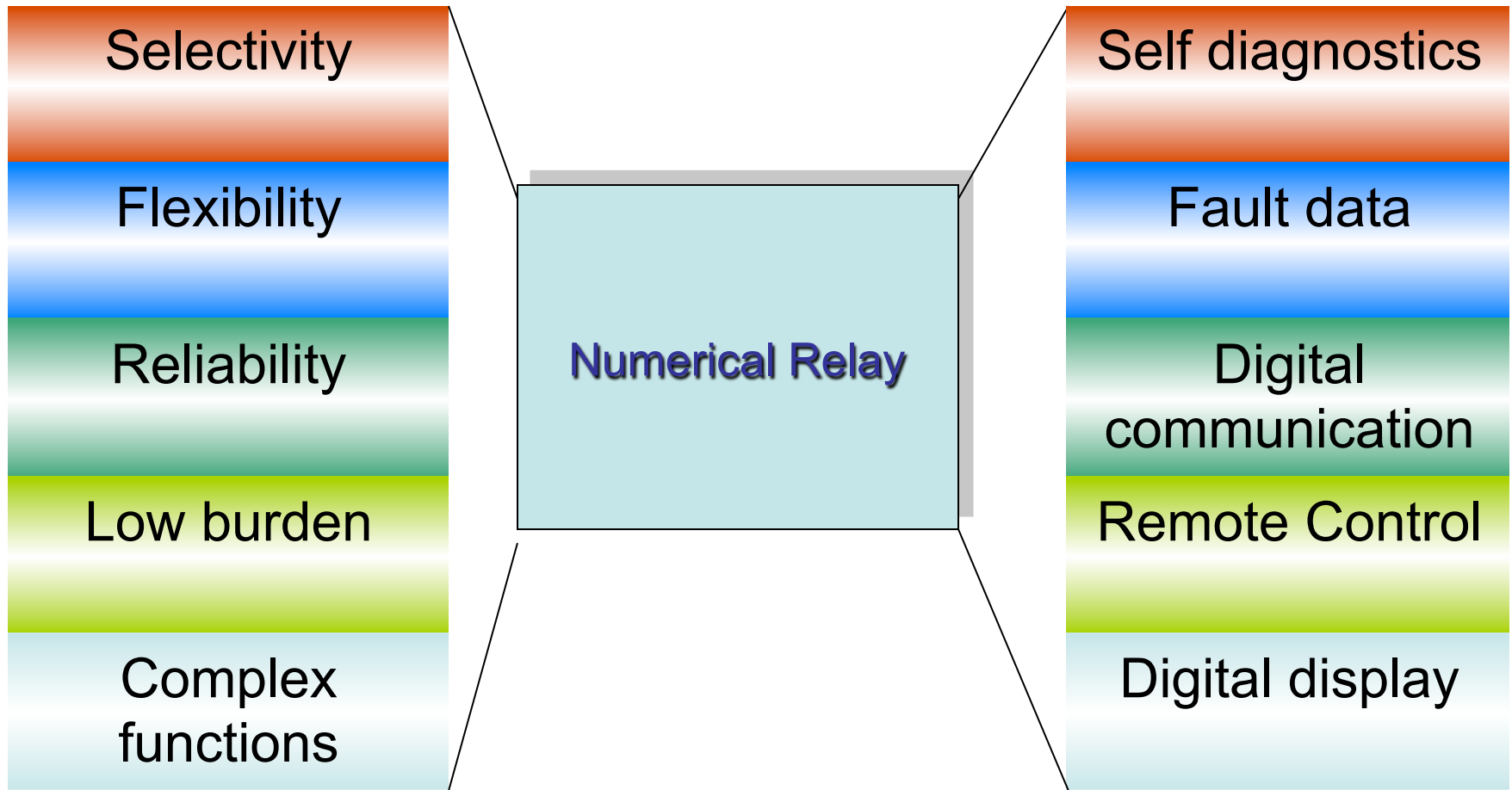
Multiple functions
or
Management with
protection

All static parts

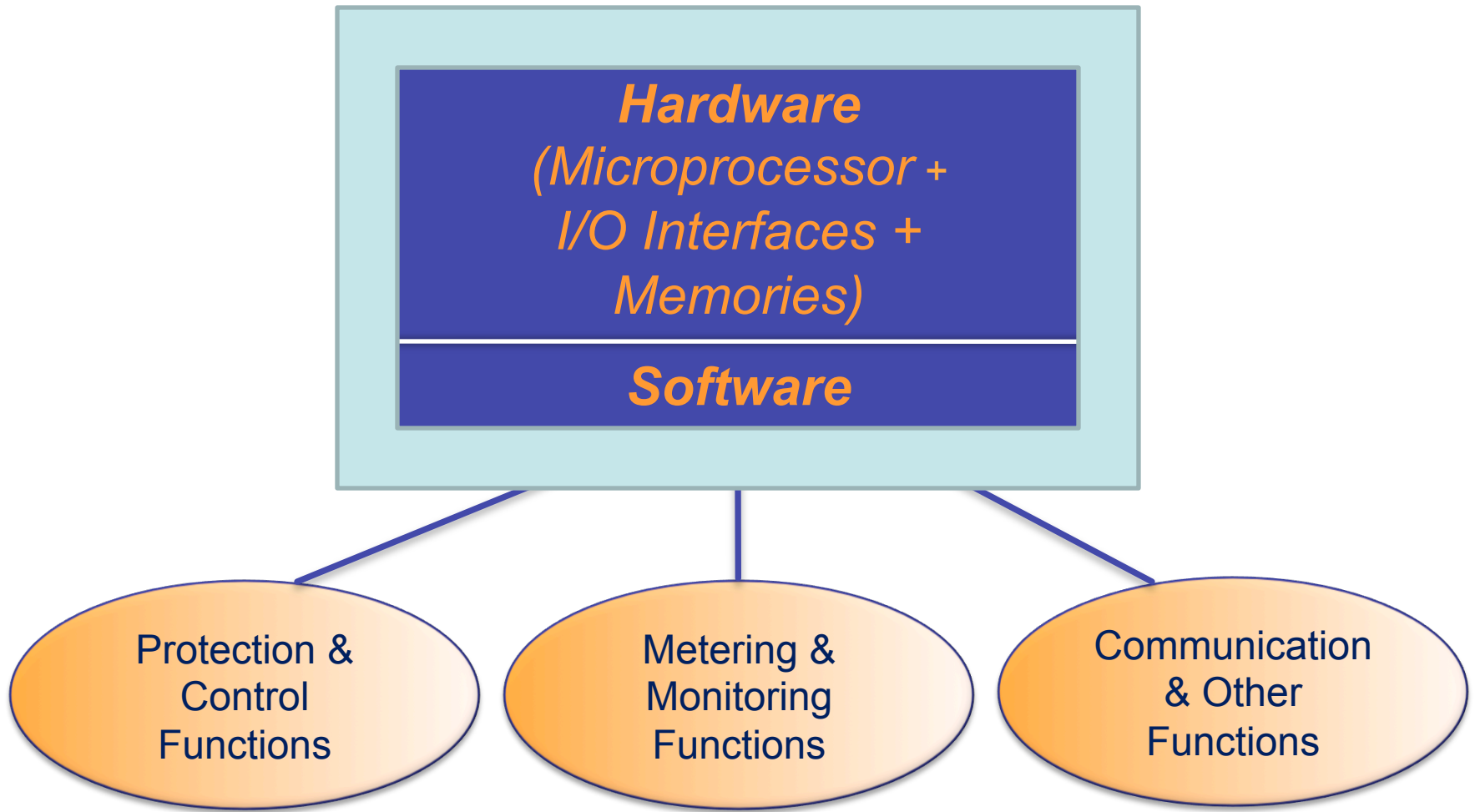
INSIDE A NUMERICAL RELAY



BENEFITS OF NUMERICAL RELAYS



INSIDE A MANAGEMENT RELAY



EXAMPLES OF COMMERCIALY AVAILABLE MANAGEMENT RELAYS

- Generator Management Relay:
GE Multilin: SR489
- Transformer Management Relay:
GE Multilin: SR489
- Feeder Management Relay:
GE Multilin: F60
- Motor Management Relay:
GE Multilin: 369

GENERATOR MANAGEMENT RELAY

SR 489 : GE Multilin

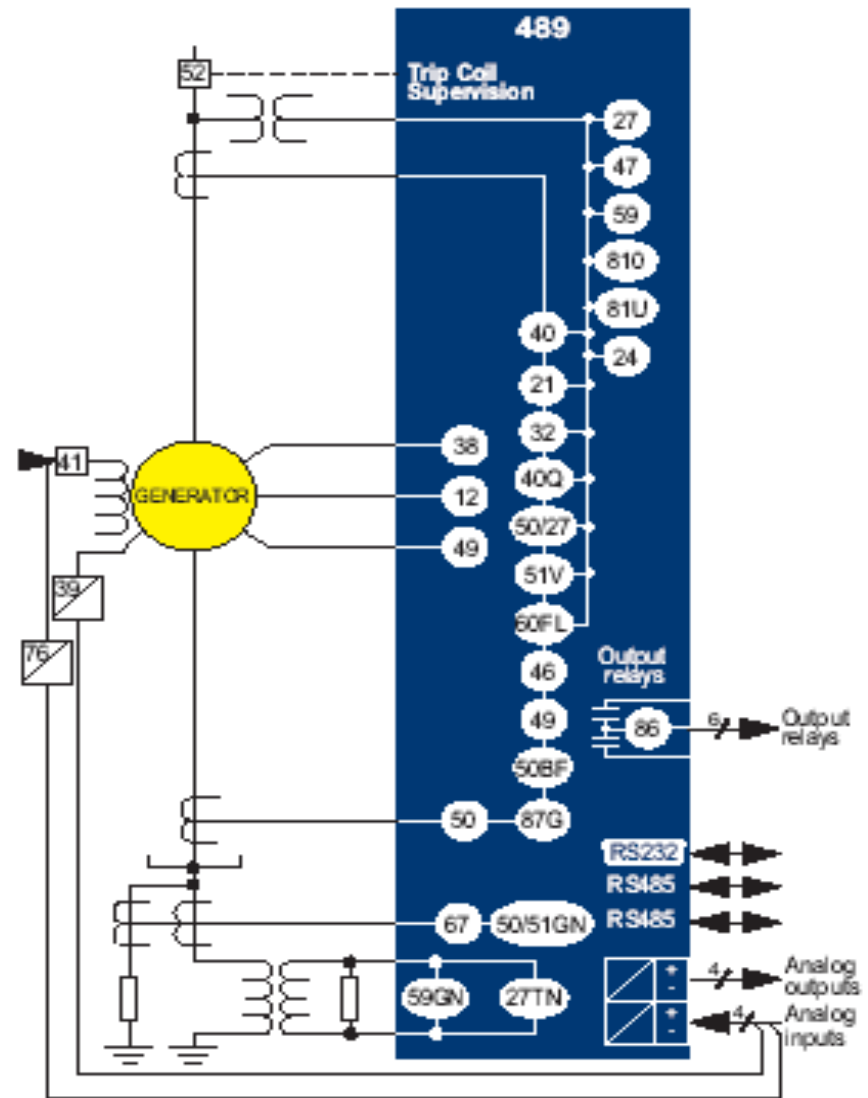


Source : <http://www.GEmultilin.com>

GENERATOR MANAGEMENT RELAY

Functional Diagram of 489

ASN	PROTECTION	5 Functionality Indication	Indication
12	overspeed	●	●
21	distance	●	●
24	volts/hertz	●	●
27	undervoltage	●	●
50/27	inadvertent generator energization	●	●
32	reverse power/low forward power	●	●
38	bearing overtemperature (RTD)	●	●
39	bearing vibration (analog inputs)	●	●
40	loss of excitation (impedance)	●	●
40Q	loss of field (reactive power)	●	●
46	negative sequence overcurrent (I^2_2t)	●	●
47	voltage phase reversal	●	●
49	stator thermal (RTD/thermal model)	●	●
50	high-set phase overcurrent	●	●
50BF	breaker failure detection	●	●
50	offline overcurrent	●	●
50/51GN	ground overcurrent	●	●
51V	voltage restrained phase overcurrent	●	●
59	overvoltage	●	●
59GN/27TH	100% stator ground	●	●
60FL	VT fuse failure	●	●
67	ground directional	●	●
76	overexcitation (analog input)	●	●
81	overfrequency/underfrequency	●	●
86	electrical lockout	●	●
87G	percentage differential	●	●
	sequential tripping logic	●	●
	trip coil supervision	●	●
	generator running hours alarm	●	●



Source: <http://www.GEmultilin.com/>

GENERATOR MANAGEMENT RELAY

Protection Functions of 489		SG	IG
12	overspeed	•	•
21	distance	•	•
24	volts/ hertz	•	
27	under voltage	•	•
5Q/27	inadvertent generator energization	•	•
32	reverse power/ low forward power	•	•
38	bearing over temperature (RTD)	•	•
39	bearing vibration (analog inputs)	•	•
40	loss of excitation (impedance)	•	
40Q	loss of field (reactive power)	•	
46	negative sequence over current (I^2_2t)	•	•
47	voltage phase reversal	•	•
49	stator thermal (RTD/ thermal model)	•	•
50	high-set phase over current	•	•
50BF	breaker failure detection	•	•

Contd..

GENERATOR MANAGEMENT RELAY

Protection Functions of 489 (Contd.)		SG	IG
50	offline over current	•	•
50/51GN	ground over current	•	•
51V	voltage restrained phase over current	•	•
59	over voltage	•	•
59GN/27TN	100% stator ground	•	•
60FL	VT fuse failure	•	•
67	ground directional	•	•
76	over excitation (analog input)	•	
81	over frequency / under frequency	•	•
86	electrical lockout	•	•
87G	percentage differential	•	•
	sequential tripping logic	•	•
	trip coil supervision	•	•
	generator running hours alarm	•	•

GENERATOR MANAGEMENT RELAY

Metering and Monitoring Functions of 489

Voltage (phasors)

Current (phasors) and Amps Demands

Real Power, MW Demand, MWh

Apparent Power and MVA demand

MW, Mvar, and \pm Mvarh demand

Frequency

Power Factor

RTD

Speed in RPM with a Key Phasor Input

User-Programmable Analog Inputs

GENERATOR MANAGEMENT RELAY

Other Functions of 489

Breaker Failure Protection

VT Fuse Failure Protection

Trip Coil Supervision Protection

Simulation

Communication

TRANSFORMER MANAGEMENT RELAY

SR 745 : GE Multilin



Source : <http://www.GEmultilin.com>

TRANSFORMER MANAGEMENT RELAY

Device	Protection Element
50/46	Negative Sequence IOC
50/87	Instantaneous Differential
50G	Ground IOC
50N	Neutral (31 ₀)IOC
50P	Phase IOC
51/46	Negative Sequence TOC
51N	Neutral (31 ₀) TOC
51P	Phase TOC
59/81	Volts-Per-Hertz
81-H5	Fifth Harmonic Level
81O	Over-frequency
81U	Under-frequency
81U-R	Frequency Decay Rate
87	Differential (Percentage)
87TG	Ground Differential
AD	Current Demand
AN-1	Analog Input Level 1
AN-2	Analog Input Level 2
	Insulation Aging
	- Aging Factor Limit
	- Hottest-Spot Limit
	- Loss of Life Limit
	Top Changer Failure
THD	Total Harmonic Distortion Level

FEEDER MANAGEMENT RELAY

F 60 : GE Multilin

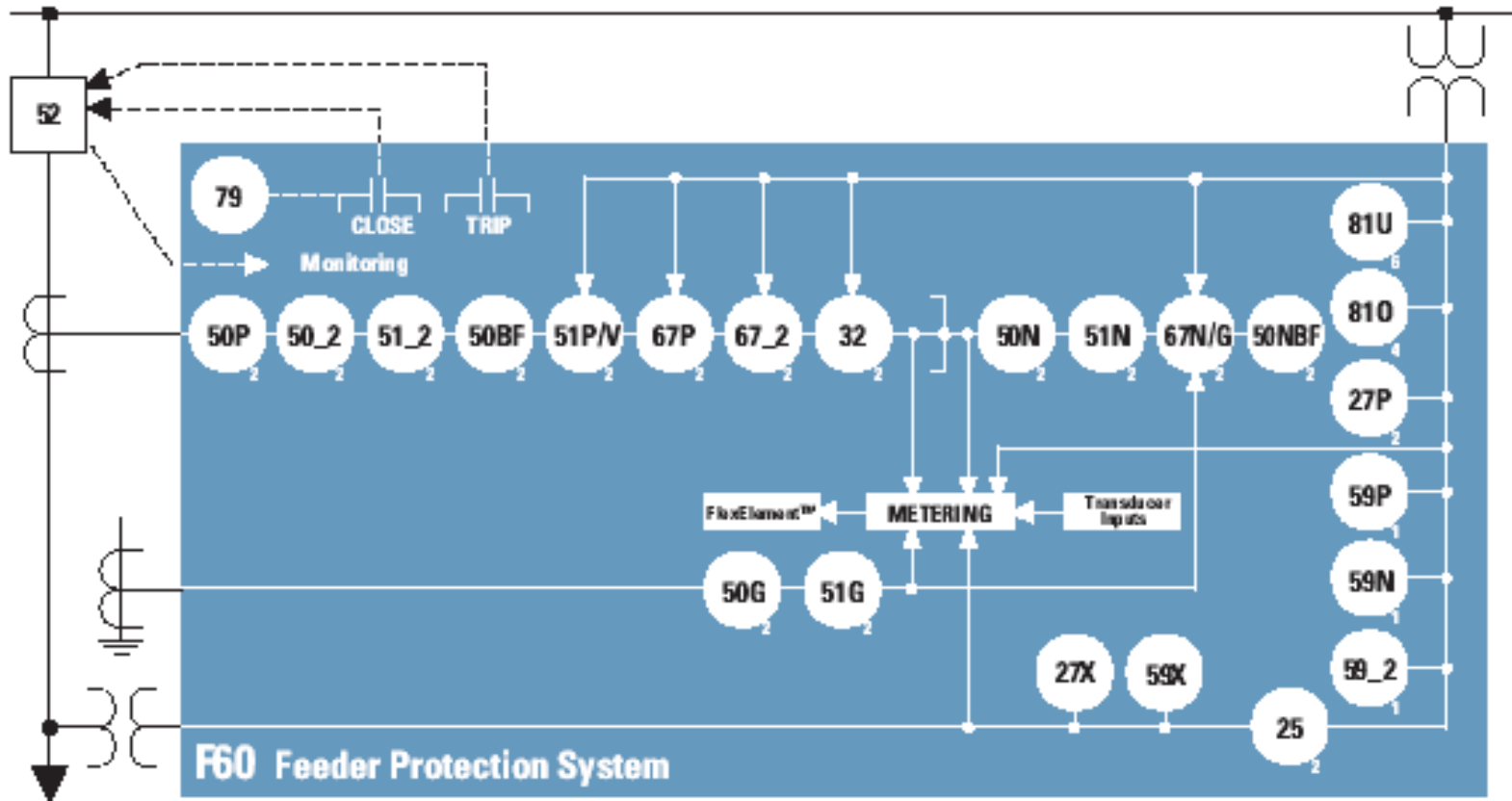


Source : <http://www.GEmultilin.com>

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FEEDER MANAGEMENT RELAY

Functional Diagram of F60



Source : <http://www.GEmultilin.com>

832727 AC.CDR

FEEDER MANAGEMENT RELAY

Device	Protection Element
25 (2)	Synchro-check
27P	Phase Under-voltage
27X	Auxiliary Under-voltage
32	Sensitive Directional Power
50BF/50BNF(2)	Breaker Failure
50DD	Disturbance Detector
50G (2)	Ground Instantaneous Overcurrent
50N (2)	Neutral Instantaneous Overcurrent
50P (2)	Phase Instantaneous Overcurrent
50_2 (2)	Negative Sequence Instantaneous
51G (2)	Overcurrent
51N (2)	Ground Time Overcurrent
51N (2)	Neutral Time Overcurrent
51P (2)	Phase Time Overcurrent
51_2 (2)	Negative Sequence Time Overcurrent
52	AC Circuit Breaker
59N	Neutral Overvoltage
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
67N (2)	Neutral Directional Overcurrent
67P (2)	Phase Directional
67_2 (2)	Negative Sequence Directional Overcurrent
79	Automatic Recloser
81O (4)	Over-frequency
81U (6)	Underfrequency

MOTOR MANAGEMENT RELAY

369 : GE Multilin

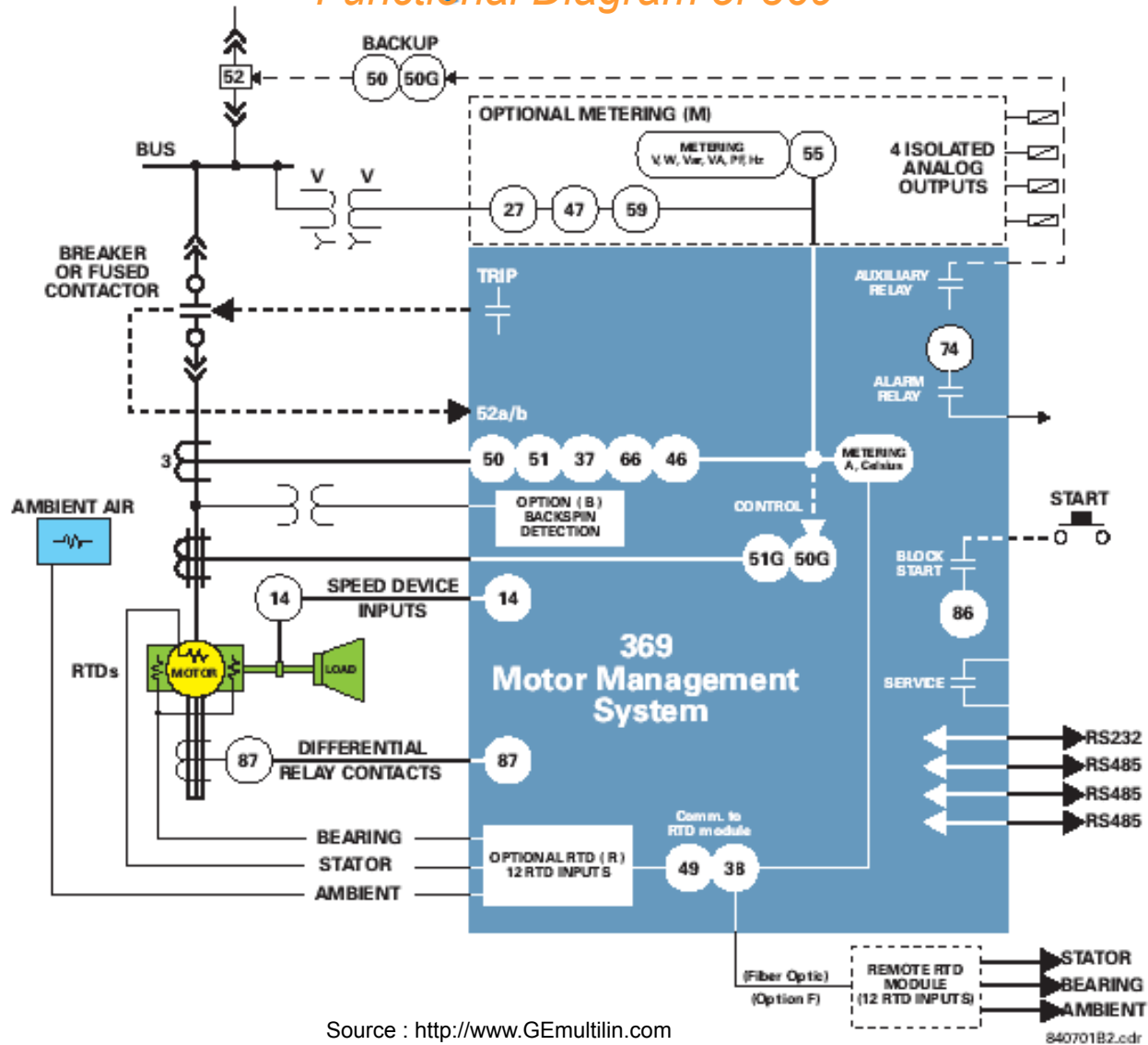


Source : <http://www.GEmultilin.com>

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MOTOR MANAGEMENT RELAY

Functional Diagram of 369



MOTOR MANAGEMENT RELAY

Device	Protection Element
14	Speed switch
27/59	Under-voltage/ Overvoltage
37	Undercurrent/ Under-power
38	Bearing RTD
46	Current Unbalance
47	Phase Reversal
49	Stator RTD
50	Short circuit and short circuit backup
50G/51G	Ground over-current and ground over-current backup
51	Overload
55	Power factor
66	Starts/ hour and time between starts
81	Frequency
86	Overload lockout
87	Differential

APPLICATION SCENERIO#1

Small Power Station : All EM Relays



APPLICATION SCENERIO#2

Mix of Static and EM Relays



APPLICATION SCENERIO#3

Only Management Relays



List of Relay Manufacturers

ABB	www.abb.com
Aplicaciones Tecnologicas	www.aplicaciones-tecnologicas-sa.es
Arteche Group	www.arteche.com
Broyce Control	www.broycecontrol.com
Crompton Instruments	www.crompton-instruments.com
DEBA	www.deba.biz
Federal Elektrik	www.federal.com.tr
GE Industrial Systems	www.geindustrial.com
Igel	www.igeelektronik.de
LS Industrial System	www.lgis.com
Newage AVK SEG	www.newage-avkseg.com
SEL	www.selindustrial.com
Siemens	www.siemens.com
SRC Devices	www.srcdevices.com
SSAC	www.ssac.com