Galdor Secotec Ltd.
Integrated Security systems

Multigard

UNDERGROUND PASSIVE MAGNETIC DETECTION SYSTEM
CMS & HWS CONFIGURATION
WITH ADAPTIVE SENSITIVITY

TECHNICAL DESCRIPTION

MN-0017-45569-A
Galdor-Secotec Ltd.
January, 2006

Contents

List of Tables

List of drawings

1. General

The **Multigard** system is a unique technology that was developed for the Israel Defense Forces to counter terrorist infiltration since the 1970's.

The original models and the updated state of the art today's version system have been installed at public and private sites in Israel and many countries all over the world.

The idea of the development was to have an underground sensor which will be based on the following requirements:

- Concealed system.
- Passive system.
- Suitable to all ground and weather conditions.
- With minimum false alarms due to environment conditions.
- With 100% probability of detection for an armed intruder.

Since the 1970's the system technology was continuously developed to have better sensitivity, reliability and modern communication.

Multigard -2000 system is the latest model comprising all proven feature with a stated of the art of signal processing and communication.

The product includes all improvements to meet **CE** standard to improve the immunity of the **Field Unit** and communication hardware to meet the requirement of **EMC** (Electro Magnetic Compatibility) directive.

The outstanding system features are as following:

* Full **concealed** and **passive**.

* Rugged steel **armored sensor cable** and Rugged **Field Unit** that meets all severe conditions for under ground installation.

* Effective operation **under any type of ground**, concrete, asphalt roads, runways, vegetation, between trees and even under water, snow and ice.

* Effective operation in **mountain Terrain** & **underwater** installation.

∗ Coverage of up to **1000m'** protection by one **Field Unit**.

∗ **Microprocessor** based signal processing including: adaptive sensitivity, auto calibrations, smart diagnostics tools, remote test and customize configuration base on flash memory.

∗ **Multiplex computerized** communication by using **CMS** configuration.

Modular standard system with coverage of up to **50 km** with a single computerized control center.

In CMS configuration there are two types of communication:
CMS withRS-485 COM4000 communication
Or
CMS with Delta Modulation COM4000 communication.

The following are the standard Field Unit, Test Unit software and their types No.:

	product	**type**
1.	Multigard CMS Field Unit with RS-485 communication and adaptive sensitivity.	
	1.1 three Detection Channels	1MFUC303
	1.2 two Detection Channels	1MFUC302
	1.3 Three Detection Channels	1MFUC301
2.	Multigard CMS Field Unit with Delta Modulation communication and adaptive sensitivity.	
	1.1 three Detection Channels	1MFUC203
	1.2 two Detection Channels	1MFUC202
	1.3 Three Detection Channels	1MFUC201
3.	Multigard HWS Field Unit with Dry contact alarm outputs and adaptive sensitivity.	
	1.4 three Detection Channels	1MFUH103
	1.5 two Detection Channels	1MFUH102
	1.6 Three Detection Channels	1MFUH101
4.	Software for Computerized Test Unit for Single loop/poles CMS or HWS configuration.	1MTSU120
5.	Software for Computerized Test Unit for Double loop CMS or HWS configuration.	1MTSU140

The Detection Loops and/or poles, which are connected to the Field Unit detection channels, can be in three configurations:

- **Single Loop-** each single Detection Loop connected to one Field Unit detection channel to create alarm zone.
- **Single Poles-** each single Line Detection Pole connected to one Field Unit detection channel to create alarm zone.
- **Double Loop-** each Two Detection Loops connected to two Field Unit detection channels to create alarm zone.

2. Principle of Operation

The **Multigard-2000** detection system based on **Magnetic Anomaly Detection (M.A.D)** principle. (Fig 1, Fig 2)

The earth's magnetic field as an outstanding natural phenomenon, allows the unique electronics of **Multigard** system to sense the change of **Earth's magnetic field,** due to a movement of ferro magnetic objects crossing sensor cable loops installed underground.

M.A.D permits **Multigard** system to sense the signal from sensor cable loops, without any additional power except the signal that are generated in the loops due to **M.A.D** principle.
Therefore, the sensor cable loops are completely passive except when **M.A.D** principle is activated by crossing the loops with Ferro magnetic object.

M.A.D permits **Multigard-2000** system to distinguish between actual intruders and stray animals, birds, winds, heavy rain, fog, snow, ice, sand storm and other bad weather conditions which generally trigger other intrusion systems.

The unique electronics allows **Multigard** system to sense small signal in the level of nano volts coming from sensor loop due to **M.A.D** principle.

The **Multigard** system essentially consists three major units :

- **Detection System – Field Unit and Detection Loops**
- **Data and power Cable**
- **Command & control center**

3. System Description

3.1 Detection System

The detection system consist of 2 main units:

- **Field Unit (FU)**
- **Detection Loops.**

3.2 General Description of Detection System

The FU is the heart of **Multigard-2000** system. Each FU controls three detection channels as follows:

3.2.1. Double loop configuration - The detection loop is arranged in a structure consist an even number of sub loops and staggered, (Fig 4) to have overlap in between each two detection loops.

A system consist single FU with three detection loops will create a detection system of two zones and multiple FU's will create a three zone out of each **FU**.

3.2.2 Single Loop/Pole configuration - A single FU with three detection loops will create a detection system of three zones.

A series of FU's and detection loops in modular construction can create a long line of protection divided into alarm zones.

The out come signals from the **FU's** will transmit via data cable to be displayed in the control center

Field Unit (FU)

Each **FU** consist the following main sub units:
(Fig 6, Fig 7).

- Analog amplifier and analog signal processing (three units).
- EMI protection unit.
- Microprocessor digital analyzer unit
- DC-DC power unit.
- Communication unit.
- Housing and connection receptacle.

Follow the sub-unit description:

3.2.3 Analog amplifier and analog signal processing

The analog amplifiers and analog signal processing unit consist the following functions:

EMI Protection

This protection is an attenuation circuitry which will attenuate any disturbance, constant or transient in between frequencies of **20Hz** and **1 GHz.** This attenuation will prevent false alarms signal coming from detection loops.

Test Stimulator

This function is activated by a Test command coming from the microprocessor via the communication line from the control center. This function creates electromagnetic signal directly on the detection loop input, simulating a real intruder signal which test the entire **Multigard-2000** system, starting with the integrity of sensor cable, through the analog amplifier, digital signal processing unit, communication interface, and communication line up to the alarm display at the control center.

Selective Amplifier

This function is a unique electronic circuit with ultra low noise features enable to pick up from the detection loop a signal of a few Nanovolt.

Adaptive threshold Control

This function selects remotely and automatically the threshold signal level which above it will create an event pulse to be processed by the microprocessor.

3.2.4 EMI Protection Unit

This unit is a combination of a shielded housing and filtering elements which are encapsulated together to protect the three analog amplifiers and analog signal processing units.

This unit protects the three analog channels from any direct EMI signal received directly into the analog channels to prevent false alarm.

3.2.5 Signal processing and setup function description.

The function of the Digital Signal Processing unit is to process all signals coming from the analog channel and to distinguish between true and false alarms created in the Field Unit..

The digital Signal Processing unit designed to have smart sensitivity auto calibration. The Signal processing mechanism will probe continually the sensor field condition and adjust it self to the optimum sensitivity.

3.2.5.1 Threshold Level Control

A combination of remote Threshold Level control and the Adaptive Threshold Level mechanism, give the user the ability to control the minimum Threshold Level, for each channel separately.

The Adaptive Threshold Level mechanism will setup automatically the optimum Threshold Level considering the User selected manual level set-up and the System environment noise.

3.2.5.2 Event Counting

A combination of remote Event Counting control and the Adaptive Event Counting mechanism, give the user the ability to control the minimum Event Counting sensitivity, for each channel separately.

The Adaptive Event Counting mechanism will setup automatically the optimum Event Counting Sensitivity considering the User manual event counting set-up and the System environment noise.

3.2.5.3 Time Windows Selector

Remote control only united for the two channels.

Test function

- **Automatic BIT Function**

  The system have an automatic **BIT function** which covers the following:

  - **BIT** for the detection unit.
  - **BIT** for the system and **Field Unit** power supply.
  - **BIT** for the communication line and transponder (CMS System).
  - **BIT** for the alarm center (CMS System).

- **Manual Test Function**

  The system have manual test actuator located at the control room. The operator can activate through the data communication a test generator which is located in each one of the **Field Unit**s.
  This test generator generates an electromagnetic signal which is induced to the **sensor cable** to check the integrity of the whole system starting with the sensor cable, through the analog amplifier, digital signal processing, communication **interface, communication** line up to the display

3.2.6 Power Requirement

In order to give a design flexibility for optimize power cable size The **Field Unit** operate from **18VDC** up to **30VDC (Vin)**, (an optional 18-72VDC). Which include **Surge and Burst Protection**. The power supply should be CE Standard quality with batteries power backup.

The total power required is **less than 1.5 watt** for three channels field unit (power required can become different depending on the type of the FU : HWS,CMS 485 or CMS Delta Modulation).

The **Field Unit** power supply is converted by the internal **DC to DC** power unit into **12VDC** and **5VDC**:

- The **12VDC** is used for the analog amplifier and analog signal processing units. Between the **Vin** and the internal **12VDC** there is a ground separation. This feature is achieved by the **DC to DC** power unit.

- The **5VDC** is used for the microprocessor digital analyzer unit.

3.2.7 Communication Unit

The **Field Unit**s are classified according to the type of the communication units.

Field Units with computerized multiplex communication unit, is defined as **CMS configuration**.

Field Units with **relay outputs** hardwire communication unit, is defined as **HWS configuration**.

3.2.7.1 C.M.S Configuration

The **CMS** configuration is based on integration between **Multigard** Field Unit and **COM4000** communication module. The module conducts the multiplex communication between the Field Unit and the computerized center.

The **COM4000XP** system is the alarm control and the command center for **Multigard** system.

The C.M.S configuration classified according to the type of the communication as follows:

- **RS485 Communication:**

  All data transmit or receive is via twisted and shielded pair of wires (data line).

  Each RS485 communication channel can hold up to 30 FU. With the distance of up to 2-4 Km with the dependency on the number of FU on the Communication line, with additional COM4000 RS-485 Repeaters units the distance can be much longer.

- **Delta Modulation:**

  All data transmit or receive is via two pairs of twisted shielded wires (the data line) , Each Delta Modulation communication channel can hold up to 64 FU. With the distance of up to 10 Km, with Repeater the distance can be much longer.

3.2.7.2 H.W.S Configuration

The HWS configuration is based on a direct connection between each one of the alarm outputs to a customized control center.

The connection is done via relay contact and multi-core communication cable.

Multigard-2000 HWS Data Line Connector Functions

Pin No.	Function	Wire color
1	Zone 1 or loop 1*	Brown
2	Zone 2 or loop 2*	Red
3	Zone 3 or loop 3*	Orange
4	System fail	Yellow
5	TXD to Test Unit	Green
6	RXD from Test Unit	Blue
7	5V Com	Violet
8	Test command	Gray
9	Direction in (double loop only)	White
10	Direction out (double loop only)	White-Black-Red
11	+Vin (15…30VDC)	White-Brown
12	Vin COM	White-Red
13	In 4 (double loop only)	White-Orange
14	Amp 1 (double loop only)	White-Yellow
15		White-Green
16	d. com	White-Blue
17		Black-White-Green
18	Analog 1	White-Gray
19	Analog 2	White-Black-Yellow
20	Analog 3	White-Black
21	12Vcom (S.G.)	White-Pink
22		White-Black-Blue
23	Com. Relays	White-Black-Brown
24		White-Black-Orange

*Note: to be determined by DIP SWITCH No. 5

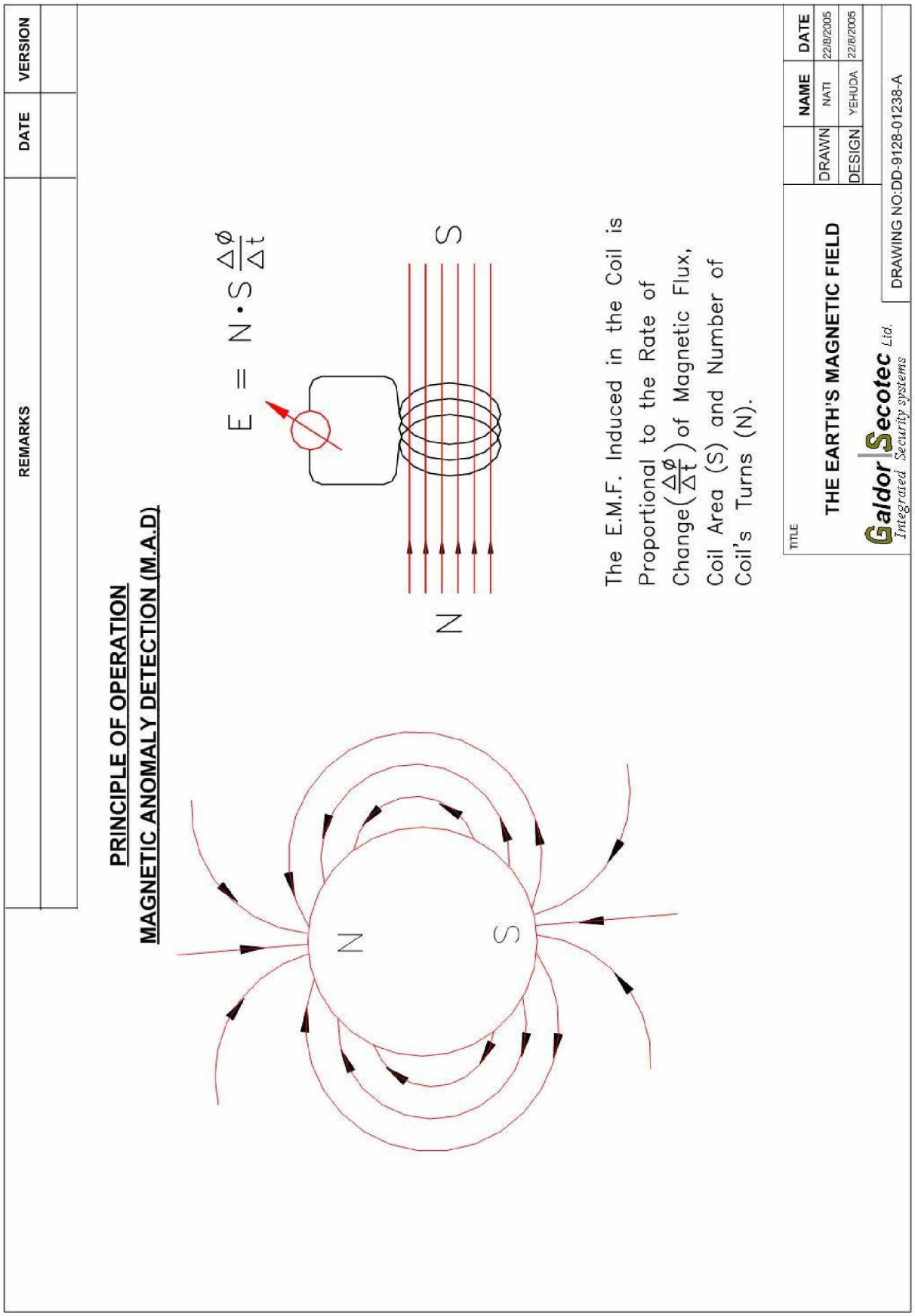


Fig 1 :M.A.D Principle of Operation

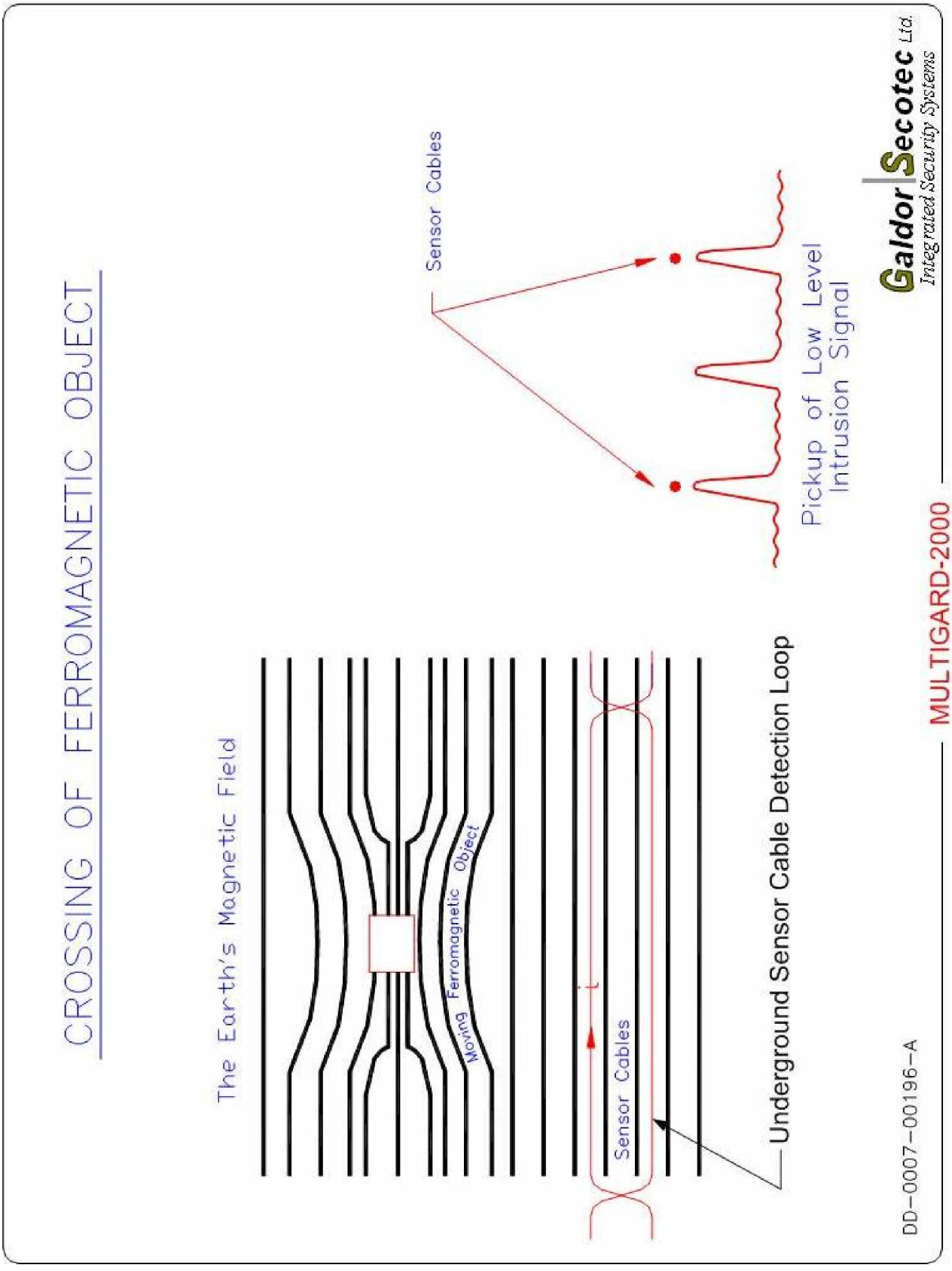


Fig 2 : Crossing of Detection Loop by ferromagnetic object

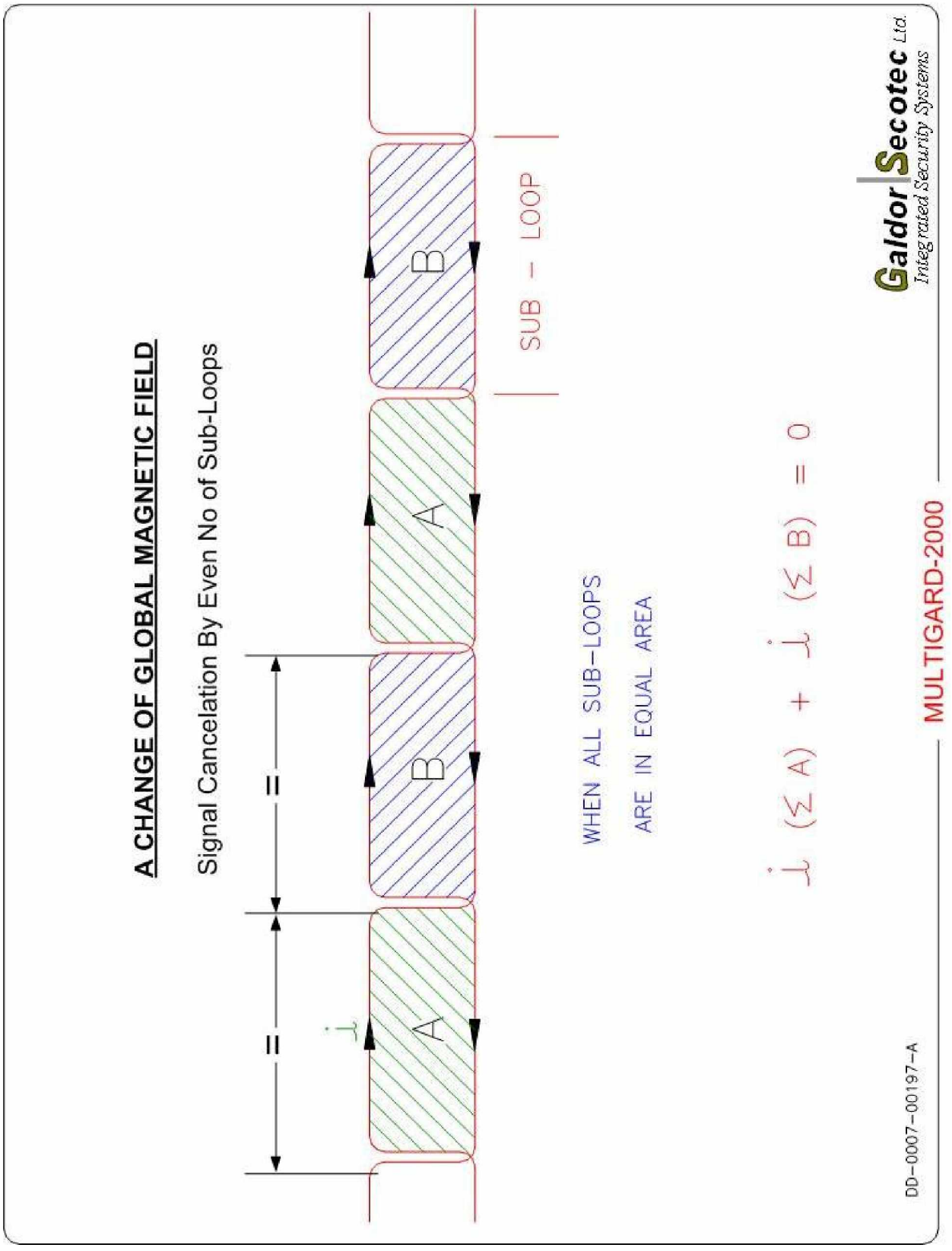


Fig 3: The principle of signal cancellation due to a global change of magnetic field

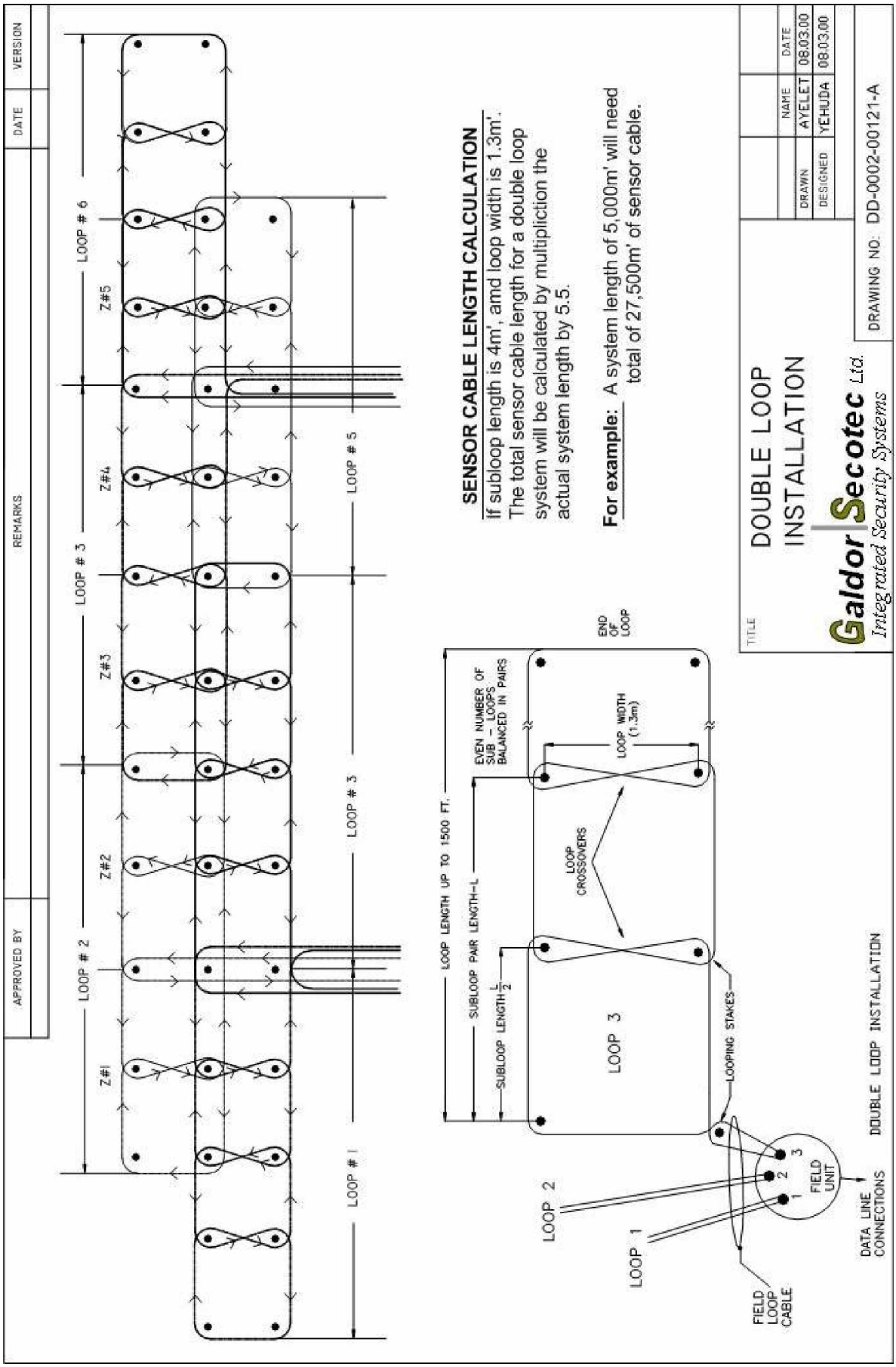


Fig 4 :Double Loop Configuration

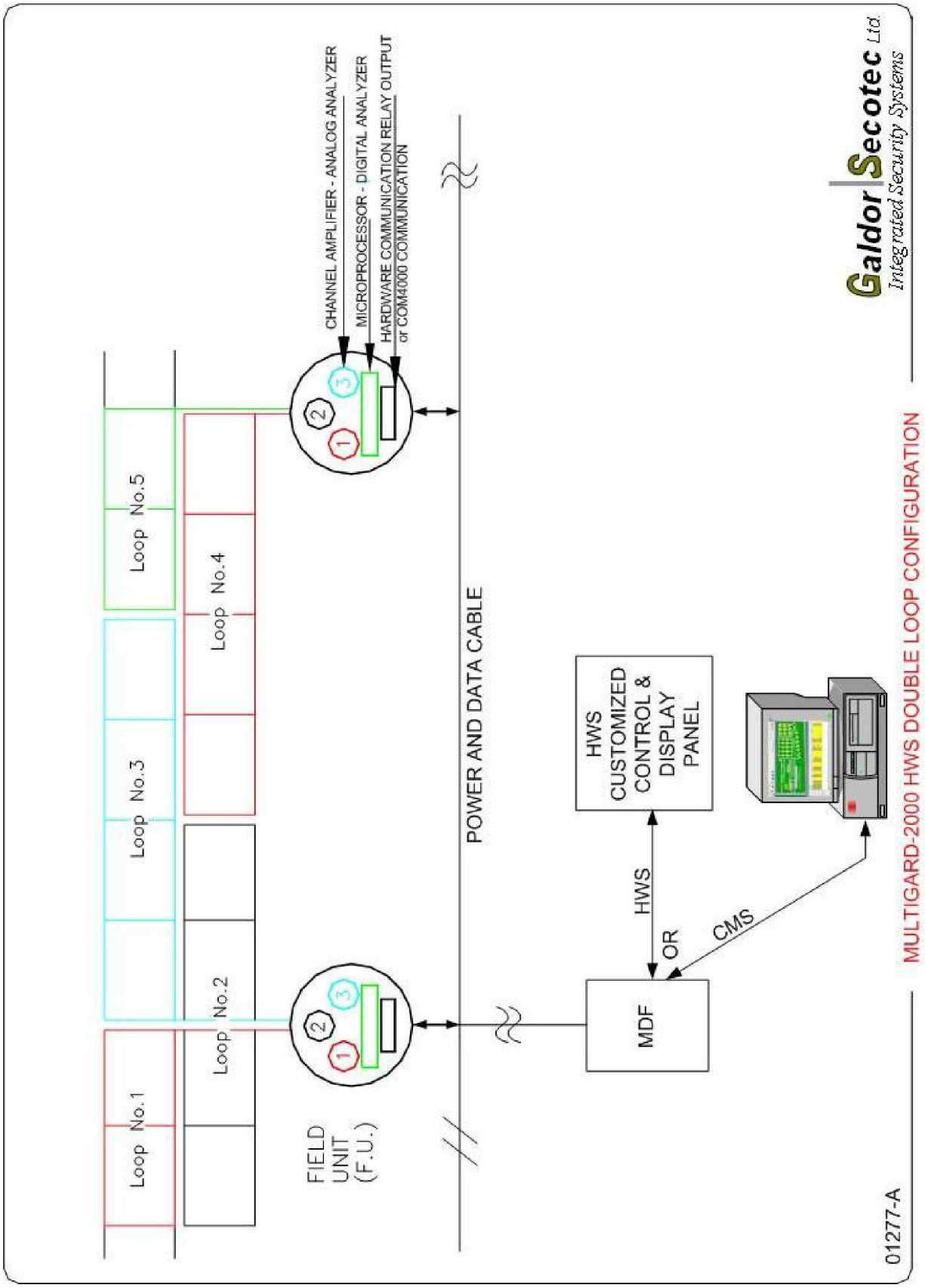


Fig 5 :System Configuration

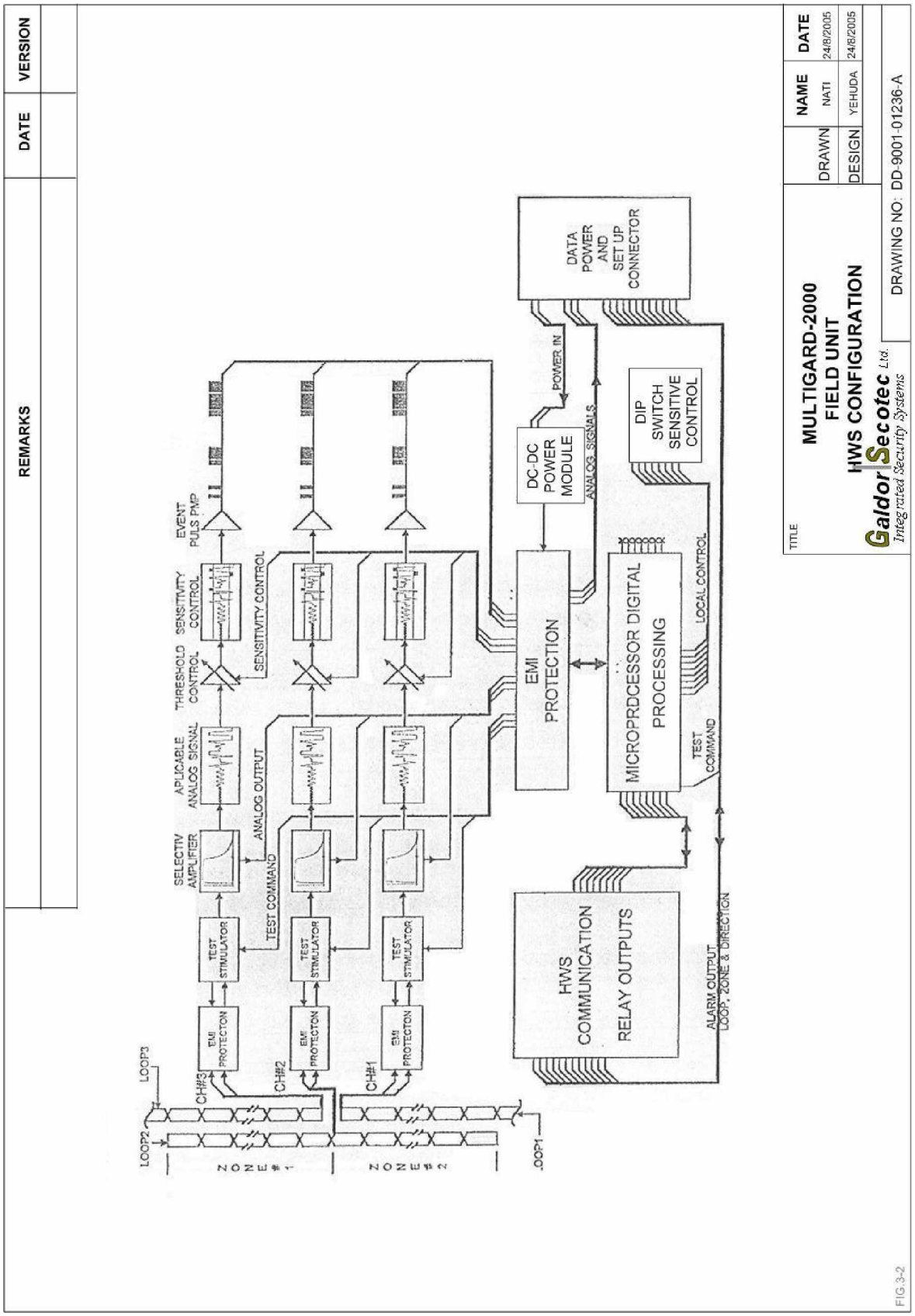


Fig 6 **:Multigard-2000 Field Unit HWS configuration**

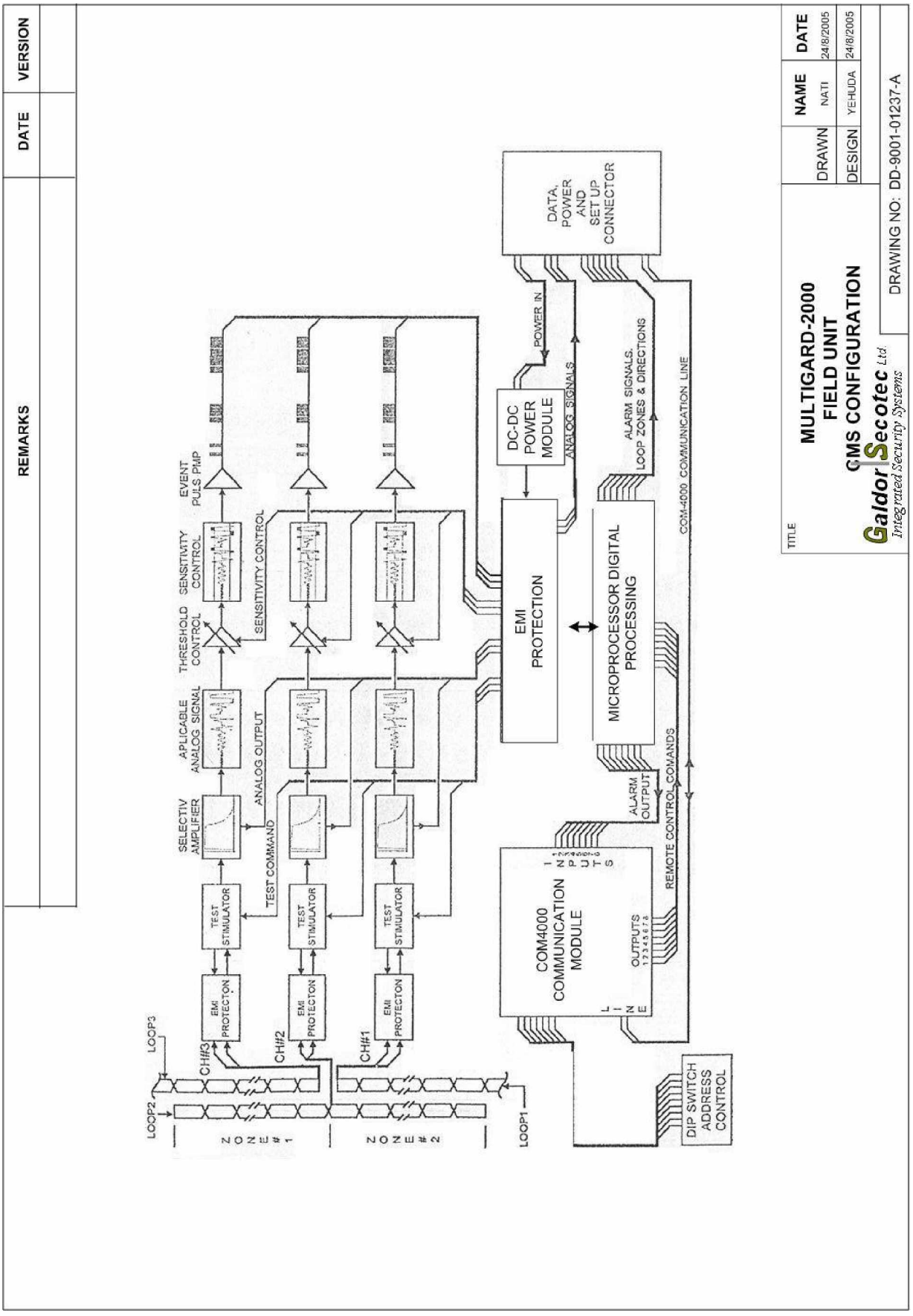


Fig 7 **:Multigard-2000 Field Unit CMS configuration**

4. FU Alarm Output (COM4000 System Inputs)

4.1 C.M.S Configuration Single Loop Or Poles:

All alarms including intrusion alarm, electronic fault, sensor fault and Low Voltage will be transmitted by the COM-4000 CMS communication to be presented on the COM4000XP color graphic display and/or on event table and will be integrated with other Systems like CCTV system & Access control system.
The Multigard FU uses 2 groups of addresses for each controller. First address for the first group is selected by the user via the dipswitch and the Second address for the second group are calculate automatically by the controller, Second address = [first address + 31].
The address of each alarm event will be as following:

G	Y	A	x	x	x	Z
Plug-in	Interface Number 1:2….N	Comm. Channel (A or B)	Controller Address (000,001:002…)			Input Number (1-8)

Table 1: COM4000XP Input object for the FU outputs (Single Loop Or Poles)

- The "G" is the COM4000XP communication plug-in prefix.
- The Y represents the number of the Interface card.
- The "A" is the Interface communication channel (can be "A" or "B").
- First 3 digits "xxx" indicate the address of controller (first or second address).
- The Z digit indicates the Input No. 1 to 8.

	Controller Alarm output Description	*Com-4000 Event Address*
First Address (Non optional objects)		
1	Intrusion Alarm 1	G1AXXX 1 Momentary activated
2	Intrusion Alarm 2	G1AXXX 2 Momentary activated
3	Intrusion Alarm 3	G1AXXX 3 Momentary activated
4	Fault Amp # 1	G1AXXX 4 Constant alarm
5	Fault Amp # 2	G1AXXX 5 Constant alarm
6	Fault Amp # 3	G1AXXX6 Constant alarm
7	Technical Fault:	G1AXXX 7 Constant alarm
8	Not In Use	G1AXXX 8

Second address (optional objects)		
1	Adaptive Level status channel 1 (bit_0)	G1AXXX 1
2	Adaptive Level status channel 1 (bit_1)	G1AXXX 2
3	Adaptive Level status channel 2 (bit_0)	G1AXXX 3
4	Adaptive Level status channel 2 (bit_1)	G1AXXX 4
5	Adaptive Level status channel 3 (bit_0)	G1AXXX 5
6	Adaptive Level status channel 3 (bit_1)	G1AXXX 6
7	Lighting – indication of Inhibiting due to a simultaneous Pulse in detection channels	G1AXXX 7
8	Lighting 5– indication of Inhibiting 5 times due to a simultaneous in the last 5 mints.	G1AXXX 8

Table 2: COM4000XP Inputs Description for the FU outputs Single Loop Or Poles.

NOTE: All second address inputs are use for reporting status of adaptive sensitivity. This address will be use only for the optional system logic.

COM4000 System Outputs - Single Loop Or Poles

all COM4000 outputs are used for remote sensitivity system including Test command and Aux outputs.
The outputs are transmitted from the COM4000XP software at the control center PC to each one of the system Field Units.

The address of each alarm event will be as following:

G	Y	A	x	x	x	T	Z
Plug-in	Interface Number 1:2….N	Comm. Channel (A or B)	Controller Address (000,001:002…)			Always T for output	Input Number (1-8)

Table 3: COM4000XP Output object for the FU Inputs

- The "G" is the COM4000XP communication plug-in prefix.
- The Y represents the number of the Interface card.
- The "A" is the Interface communication channel (can be "A" or "B").
- First 3 digits "xxx" indicate the address of controller (first or second address).
- The T digit is a constant of Output object.
- The Z digit indicates the Output No. 1 to 8.

The following are the different COM4000 System Outputs for Single Loop Or Poles system:

	Controller Inputs Description (COM4000 Outputs)	*Com-4000 Event Address*
First Address (Non optional objects)		
1	Event Counting Channel 1	G1AXXXT**1**
2	Event Counting Channel 2	G1AXXXT**2**
3	Event Counting Channel 3	G1AXXXT**3**
4	Threshold Level Channel 1 (Bit 0)	G1AXXXT**4**
5	Threshold Level Channel 1 (Bit 1)	G1AXXXT**5**
6	Test Command	G1AXXXT**6** Momentary activated
7	Threshold Level Channel 2 (Bit 0)	G1AXXX**T7**
8	Threshold Level Channel 2 (Bit 1)	G1AXXXT**8**
Second address (optional objects)		
1	Threshold Level Channel 3 (Bit 0)	G1AXXXT1
2	Threshold Level Channel 3 (Bit 1)	G1AXXXT2
3	Time Windows	G1AXXXT3
4	Local output 1	G1AXXXT4
5	Local output 2	G1AXXXT5
6	Local output 3	G1AXXXT6
7	Not in use	G1AXXXT7
8	Reset Adaptive mechanism	G1AXXXT8

Table 4: COM4000XP outputs Description for the FU Inputs

4.2 C.M.S Configuration Double Loop:

All intrusion alarm, including electronic fault, sensor fault and Low Voltage will be transmitted by the COM-4000 CMS communication to be presented on the COM4000XP color graphic display and/or on event table and will be integrated with other Systems like CCTV system & Access control.

The Multigard FU uses 2 groups of addresses for each controller. First address for the first group is set-up by the user via the dipswitch and the Second address for the second group are calculate automatically by the controller, Second address = [first address + 31].

The address of each alarm event will be as following:

G	**Y**	**A**	**x**	**x**	**x**	**Z**
Plug-in	Interface Number 1:2….N	Comm. Channel (A or B)	Controller Address (000,001:002…)			Input Number (1-8)

Table 5: COM4000XP Input object for the FU outputs (Double Loop)

- The "G" is the COM4000XP communication plug-in prefix.
- The Y represents the number of the Interface card.
- The "A" is the Interface communication channel (can be "A" or "B").
- First 3 digits "xxx" indicate the address of controller (first or second address).
- The Z digit indicates the Input No. 1 to 8.

	Controller Alarm output Description	***Com-4000 Event Address***
First Address (Non optional objects)		
1	Intrusion Alarm 1	G1AXXX 1 Momentary activated
2	Intrusion Alarm 2	G1AXXX 2 Momentary activated
3	Intrusion Alarm 3	G1AXXX 3 Momentary activated
4	Fault Amp # 1	G1AXXX 4 Constant alarm
5	Fault Amp # 2	G1AXXX 5 Constant alarm

6	Fault Amp # 3	G1AXXX6 Constant alarm
7	Direction In:	G1AXXX 7 Momentary activated
8	Direction Out:	G1AXXX 8 Momentary activated

Second address (optional objects)		
1	Adaptive Level status channel 1 (bit_0)	G1AXXX 1
2	Adaptive Level status channel 1 (bit_1)	G1AXXX 2
3	Adaptive Level status channel 2 (bit_0)	G1AXXX 3
4	Adaptive Level status channel 2 (bit_1)	G1AXXX 4
5	Adaptive Level status channel 3 (bit_0)	G1AXXX 5
6	Adaptive Level status channel 3 (bit_1)	G1AXXX 6
7	Lighting – indication of Inhibiting due to a simultaneous Pulse in detection channels	G1AXXX 7
8	Lighting 5– indication of Inhibiting 5 times due to a simultaneous in the last 5 mints.	G1AXXX 8

Table 6: COM4000XP Inputs Description for the FU outputs Double Loop

NOTE: All second address inputs are use for reporting status of adaptive sensitivity. This address will be use only for the optional system logic.

Controller Inputs COM4000 System Outputs - Double Loop

All COM4000 Outputs including remote sensitivity control, System Test and Aux. outputs. Will be transmitted from COM4000XP software via the COM4000 CMS communication to the Multigard FU.

The Multigard FU uses 2 addresses for each controller. First Address is selected by the user via the dipswitch and the Second address calculate automatically by the controller, Second address = [first address + 31].

The address of each alarm event will be as following:

G	Y	A	x	x	x	T	Z
Plug-in	Interface Number 1:2….N	Comm. Channel (A or B)	Controller Address (000,001:002…)			Always T for output	Output Number (1-8)

Table 7: COM4000XP Output object for the FU Inputs

- The "G" is the COM4000XP communication plug-in prefix.
- The Y represents the number of the Interface card.
- The "A" is the Interface communication channel (can be "A" or "B").
- First 3 digits "xxx" indicate the address of controller (first or second address).
- The T digit is a constant of Output object.
- The Z digit indicates the Output No. 1 to 8.

The following are the different COM4000 System Outputs for Double Loop system:

	Controller Inputs Description (COM4000 Outputs)	***Com-4000 Event Address***
First Address (Non optional objects)		
1	Event Counting Channel 1	G1AXXXT**1**
2	Event Counting Channel 2	G1AXXXT**2**
3	Event Counting Channel 3	G1AXXXT**3**
4	Threshold Level Channel 1 (Bit 0)	G1AXXXT**4**
5	Threshold Level Channel 1 (Bit 1)	G1AXXXT**5**
6	Test Command	G1AXXXT**6** Momentary activated
7	Threshold Level Channel 2 (Bit 0)	G1AXXX **T7**
8	Threshold Level Channel 2 (Bit 1)	G1AXXXT**8**
Second address (optional objects)		
1	Threshold Level Channel 3 (Bit 0)	G1AXXXT1
2	Threshold Level Channel 3 (Bit 1)	G1AXXXT2
3	Time Windows	G1AXXXT3
4	Local output 1	G1AXXXT4
5	Local output 2	G1AXXXT5
6	Local output 3	G1AXXXT6
7	Not in use	G1AXXXT7
8	Reset Adaptive mechanism	G1AXXXT8

Table 8: COM4000XP outputs Description for the FU Inputs

5. Default Processing Parameter for each channel A&B

	Description	Value
1	Inhibiting time after alarm	15 sec
2	Acceptable Max Event Pulse width	0.360 sec
3	Acceptable Min Event Pulse width	0.100 sec
4	Event pulse width for Constant Alarm output	10 sec (and longer**)**
5	Power up time	80 sec
6	Alarm time	5 sec

Table 9: Processing Parameter

NOTE: all the above parameters can be change by authorized user to meet an actual detection condition by using Galdor computerized test unit & Setup software.

6. Detection Sensitivity Set-Up

6.1 CMS system set-up

6.1.1 Event Counting - Remote Control & adaptive

The event counting parameter defines how many legal events (see table #10) will be required in the time windows to create an alarm.
The user can select the minimum Event counting by setup one of the COM-4000 output for each one of the channel individually.
The Adaptive Event Counting mechanism will setup automatically the optimum Event Counting considering the User choice and the System environment noise.

Channel 1 Event Counting	**XXXT1 (First Address)**
2 (High Sensitivity)	OFF
3 (Low Sensitivity)	ON
Channel 2 Event Counting	**XXXT2 (First Address)**
2 (High Sensitivity)	OFF
3 (Low Sensitivity)	ON
Channel 3 Event Counting	**XXXT3 (First Address)**
2 (High Sensitivity)	OFF
3 (Low Sensitivity)	ON

Table 10: Minimum Event Counting - Remote Control Outputs

6.1.2 **Threshold Level – Remote Control & Adaptive*:***

The user can select remotely the minimum Threshold level by setup Combination of two (2) COM-4000 outputs for each channel individually. The Adaptive Threshold Level mechanism will setup automatically the optimum Threshold Level considering the User initial set-up and the System environment noise.

Channel 1 Event Level	**XXXT4 (First Address)**	**XXXT5 (First Address)**
1 (High Sensitivity)	OFF	OFF
2	ON	OFF
3	OFF	ON
4 (Low Sensitivity)	ON	ON
Channel 2 Event Level	**XXXT7 (First Address)**	**XXXT8 (First Address)**
1 (High Sensitivity)	OFF	OFF
2	ON	OFF
3	OFF	ON
4 (Low Sensitivity)	ON	ON
Channel 3 Event Level	**XXXT1 (Second Address)**	**XXXT2 (Second Address)**
1 (High Sensitivity)	OFF	OFF
2	ON	OFF
3	OFF	ON
4 (Low Sensitivity)	ON	ON

Table 11: Minimum Threshold Level - Remote Control Outputs for Com4000XP

6.1.3 Time Windows – Remote Control only

The Time Windows is a parameter that define to the microcontroller the life cycle of an event for counting purpose.
The user can select the required time windows by setup one of the COM4000 output. With this output the user will control from remote witch one of the two (2) time windows is active, the selection is between 6 sec up to 9 sec and will set it on the two channels.

channels 1,2&3 Time WINDOWS	**XXXT3 (Second Address)**
6 sec (Low Sensitivity)	ON
9 sec (High Sensitivity)	OFF

Table 12: Time Windows - Remote Control Outputs

6.2 HWS system set-up

Detection parameters and sensitivity control in **HWS** configuration is done by a DIP switch located on top of the **Field Unit**.
The functions are as follow:

6.2.1. Event Counting - User definition & adaptive

The event counting parameter defines how many legal events (see table #13) will be required in the time windows to create an alarm.
The user can select the minimum Event counting by setup one of the DIP switch for each one of the channel individually.
The Adaptive Event Counting mechanism will setup automatically the optimum Event Counting Sensitivity considering the User choice and the System environment noise.

Channel 1, 2, 3 Event Counting	**Switch no. 1 (on the DIP switch)**
2 (High Sensitivity)	OFF
3 (Low Sensitivity)	ON

Table 13: Minimum Event Counting - Dip Switch setup (HWS)

6.2.2. Threshold Level – User definition & Adaptive :

The user can select locally at each FU the minimum Threshold level by setup Combination of two (2) Dip switch No.4 & No.5, this two (2) Dip Switches control all three (3) channels simultaneously.

The Adaptive Threshold Level mechanism will setup automatically for each channel individually the optimum Threshold Level Sensitivity considering the User initial set-up and the System environment noise.

Channel 1 Event Level	**Switch no. 2 (on the DIP switch)**	**Switch no. 3 (on the DIP switch)**
1 (High Sensitivity)	OFF	OFF
2	ON	OFF
3	OFF	ON
4 (Low Sensitivity)	ON	ON
Channel 2 Event Level	**Switch no. 4 (on the DIP switch)**	**Switch no. 5 (on the DIP switch)**
1 (High Sensitivity)	OFF	OFF
2	ON	OFF
3	OFF	ON
4 (Low Sensitivity)	ON	ON
Channel 3 Event Level	**Switch no. 6 (on the DIP switch)**	**Switch no. 7 (on the DIP switch)**
1 (High Sensitivity)	OFF	OFF
2	ON	OFF
3	OFF	ON
4 (Low Sensitivity)	ON	ON

Table 14: Minimum Threshold Level - Dip Switch setup (HWS)

6.2.3. Time Windows – User definition only

The Time Windows is a parameter that define to the microcontroller the life cycle of an event for counting purpose.

The user can select the required time windows by setup one of the Dip switch. With this Dip switch the user will control witch one of the two (2) time windows is active, the selection is between 6 sec up to 9 sec and will set it on the two channels.

channels 1,2&3 Time WINDOWS	**Switch no. 8 (on the DIP switch)**
6 sec (Low Sensitivity)	ON
9 sec (High Sensitivity)	OFF

Table 15: Time Windows - Dip Switch setup (HWS)

7. CMS Address

7.1 CMS RS485 communication

Each FU has two (2) addresses "First address" and "Second Address". **First address** is selected by the user via Dip switch located on top of the **Field Unit**. The address will be defined by 5 switches (1-5) in binary code to give total of 31 addresses 000 up to 030.

The **Second Address** calculates automatically by the FU by adding 32 to the First address, total sum of 31 addresses 031 up to 061.

The following table shows for each one of the **First address** its **Dip switch** setup and the automatically value of **Second Address**.

First Address	Address on the Dip switch					Seconded Address
	1	**2**	**3**	**4**	**5**	
0	0	0	0	0	0	31
1	1	0	0	0	0	32
2	0	1	0	0	0	33
3	1	1	0	0	0	34
4	0	0	1	0	0	35
5	1	0	1	0	0	36
6	0	1	1	0	0	37
7	1	1	1	0	0	38
8	0	0	0	1	0	39
9	1	0	0	1	0	40
10	0	1	0	1	0	41
11	1	1	0	1	0	42
12	0	0	1	1	0	43
13	1	0	1	1	0	44
14	0	1	1	1	0	45
15	1	1	1	1	0	46
16	0	0	0	0	1	47
17	1	0	0	0	1	48
18	0	1	0	1	0	49
19	1	1	0	0	1	50
20	0	0	1	0	1	51
21	1	0	1	0	1	52
22	0	1	1	0	1	53
23	1	1	1	0	1	54

24	0	0	0	1	1	55
25	1	0	0	1	1	56
26	0	1	0	1	1	57
27	1	1	0	1	1	58
28	0	0	1	1	1	59
29	1	0	1	1	1	60
30	0	1	1	1	1	61

Table 16: FU address setup

7.2 CMS Delta Modulation communication

Each FU has two (2) addresses "First address" and "Second Address". **First address** is selected by the user via Dip switch located on top of the **Field Unit**. The address will be defined by 6 switches (1-6) in binary code to give total of 64 addresses 000 up to 064.
The **Second Address** calculates automatically by the FU by adding 64 to the First address, total sum of 64 addresses 063 up to 127.

The following table shows for each one of the **First address** its **Dip switch** setup and the automatically value of **Second Address**.

First Address	**Address on the Dip switch**						**Seconded Address**
	1	**2**	**3**	**4**	**5**	**6**	
0	0	0	0	0	0	0	64
1	1	0	0	0	0	0	65
2	0	1	0	0	0	0	66
3	1	1	0	0	0	0	67
4	0	0	1	0	0	0	68
5	1	0	1	0	0	0	69
6	0	1	1	0	0	0	70
7	1	1	1	0	0	0	71
8	0	0	0	1	0	0	72
9	1	0	0	1	0	0	73

10	0	1	0	1	0	0	74
11	1	1	0	1	0	0	75
12	0	0	1	1	0	0	76
13	1	0	1	1	0	0	77
14	0	1	1	1	0	0	78
15	1	1	1	1	0	0	79
16	0	0	0	0	1	0	80
17	1	0	0	0	1	0	81
18	0	1	0	1	1	0	82
19	1	1	0	0	1	0	83
20	0	0	1	0	1	0	84
21	1	0	1	0	1	0	85
22	0	1	1	0	1	0	86
23	1	1	1	0	1	0	87
24	0	0	0	1	1	0	88
25	1	0	0	1	1	0	89
26	0	1	0	1	1	0	90
27	1	1	0	1	1	0	91
28	0	0	1	1	1	0	92
29	1	0	1	1	1	0	93
30	0	1	1	1	1	0	94
31	1	1	1	1	1	0	95
32	0	0	0	0	0	1	96
33	1	0	0	0	0	1	97
34	0	1	0	0	0	1	98
35	1	1	0	0	0	1	99
36	0	0	1	0	0	1	100
37	1	0	1	0	0	1	101
38	0	1	1	0	0	1	102
39	1	1	1	0	0	1	103
40	0	0	0	1	0	1	104
41	1	0	0	1	0	1	105
42	0	1	0	1	0	1	106
43	1	1	0	1	0	1	107
44	0	0	1	1	0	1	108
45	1	0	1	1	0	1	109
46	0	1	1	1	0	1	110
47	1	1	1	1	0	1	111
48	0	0	0	0	1	1	112
49	1	0	0	0	1	1	113

50	0	1	0	1	0	1	114
51	1	1	0	0	1	1	115
52	0	0	1	0	1	1	116
53	1	0	1	0	1	1	117
54	0	1	1	0	1	1	118
55	1	1	1	0	1	1	119
56	0	0	0	1	1	1	120
57	1	0	0	1	1	1	121
58	0	1	0	1	1	1	122
59	1	1	0	1	1	1	123
60	0	0	1	1	1	1	124
61	1	0	1	1	1	1	125
62	0	1	1	1	1	1	126
63	1	1	1	1	1	1	127

Table 17: FU address setup

8. Test Unit

In order to set up the controller to the desired sensitivity, a dedicated computerized test unit Type **1MTSU120** software will be use for single loop/poles system configuration, and Type **1MTSU140** software for double loop system configuration

8.1 Test Unit Type 1MTSU120 and Test Unit Type 1MTSU140

by connecting the Test Unit PC serial port to the Field Unit data connector on the connection box, enable the user to measure, analyze and set-up the sensitivity and operation function of all types HWS and CMS Multigard Field Units.

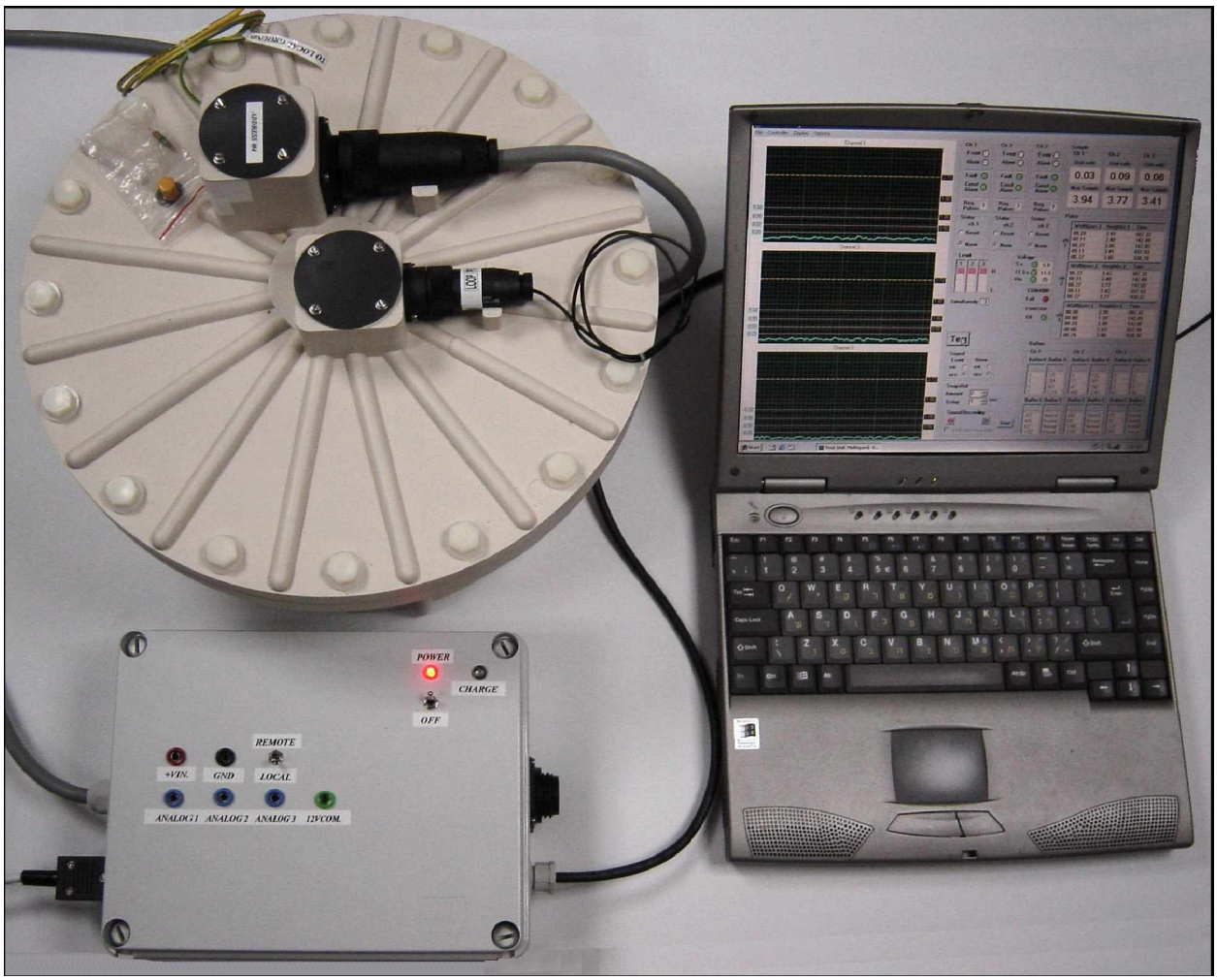


Fig 8 **:Typical Laboratory Test Unit and Field Unit Test Setup**

The Test Unit Software includes three channel Real Time Analog & Digital Detection signal display which eliminate the need of voltage measuring device such as DVM or scope. The Test Unit Software enables the user to operate and/or measure the following parameters:

- Input Voltage (Vin).
- Internal Power Regulator 11.5VDC & 5 VDC.
- F.U. internal Power status indication (OK/ Fault).
- Analog Detection signals channel 1,2 and 3.
- Digital Detection Minimum/Maximum channel 1,2 and 3.
- Event Pulse channel 1,2 and 3.
- Alarm channel 1,2 and 3.
- Fault channel 1,2 and 3.
- Constant Alarm channel 1,2 and 3.
- Communication status with the COM4000XP (CMS Only).
- View of legal event information.
- Adaptive sensitivity status.
- Activate Test Command.
- Reset the adaptive sensitivity mechanism to Max sensitivity.
- Test unit screen snapshot; manually or by setup automatic trigger.
- Template: download to Field Unit Microprocessor of predefine detection parameters.
- Select operation mode and setup the automatic sensitivity Field Unit behavior.

For more information see MN-0522-45570-A (1MTSU120 - Multigard software test unit) manual.

9. Test Command

9.1 CMS system

The Multigard system have manual test function, The operator can activate the test command from the COM4000XP by turning on and than turning off output XXXT6 of the **First address**.

As result to the Turning "OFF" the output XXXT6 the FU will receive a command to activate Test Routine through the data communication and a test will generate by a test mechanism which is located in each one of the **Field Unit**s or to individual Field Unit.

This test mechanism generates an electromagnetic signal which is induced to the **sensor cable** to check the integrity of the whole system starting with the sensor cable, through the analog amplifier, digital signal processing, communication **interface, communication** line up to the display.

9.2 HWS system

The activation of test command in HWS system is done by the operator using momentary switch to shorten two wires of the data cable.
The data common wire and the test command wire coming separately from each one of the HWS Field Unit.
The test generator will generates an electromagnetic signal which is induced to the **sensor cable** to check the integrity of the whole system starting with the sensor cable, through the analog amplifier, digital signal processing and the , alarm relay.

10. Housing and Connection Receptacle

The housing of **Field Unit** is made of reinforce polyurethane plastic. Container, cover and screws all made of plastic. The housing is waterproof and 100% corrosion resistance.

On top of the **Field Unit** there are three receptacles as following:

- Seven pins receptacle to connect three detection loops.
- Twenty four pins receptacle to connect **HWS**data cable and or a dedicated **Test Unit** for operating and setting up the **Field Unit**.
- Seven pins receptacle to connect **COM-4000XP** communication line (CMS Delta Modulation only)

The two receptacles for sensor cable **Test Unit** functions and housing are identical for **CMS** and **HWS Field Unit**.

11. Detection Loops

The loops enable pickup low level electrical intrusion signals to be detected by the **Field Unit**.

The loop cable generally is an armored cable for underground installation. The cable is used in a high degree of mechanical protection and flexible to be installed directly into the ground.

The loop resistance should be less than 8Ω.

The typical cable technical requirements are as follow:

- High conductive copper wire.
- PVC insulation with dielectric strength of 1000V between conductors and steel tape.
- Protected by double galvanized steel tape, thickness of 0.3 mm with 100% coverage.
- Insulation between cores and armored 50 M ohms.
- Insulation between armored and ground min. 20M ohms, when immersed in water.

The detection loops are constructed in sub loops. The typical sub loops dimension is **5 m'** in length by **1.2 m'** width. The entire loop which it is constructed in sub loops is **Max. 660 m'**.
For example for a loop of **660 m'** the number of sub loops will be **132** which it is an even number of sub loops. The total length of cable for **660 m** loops's length will be about **3600 m'.**
The length of sub loops can be shorter or longer with respect to the electromagnetic environment.

12. Data & Power Cable

The data & Power cable is multi core armored cable connecting all **Field Unit**s to the central control unit.
The data & Power cable functions are:

- Carrying signals between **Field Unit**s and control center.
- Supplying DC power to **Field Unit**s.
- Providing data in between **Field Unit**s.
- Providing common ground network for data connection in between **Field Units**.

The data & Power cable size is designed to meet system configuration requirements for **HWS** configuration or **CMS** configuration.

With **HWS configuration** the number of required wires is **2N + 8** when **N** is the number of zones.

With **CMS configuration** the number of wires required is **8** for any number of zones.
Size of data cable is optimized according to the amount of **Field Unit**s, length of zones, distance from control center and power supply voltage.

13. Command and Control Center

The type of command and control center is effected by several basic factors that must be taken into consideration, among those are:

- The total length of the actual project.
- The number of alarm zones.
- The distance of control room from the protected line.
- The necessary of integration of other detection and warning alarm devices.
- The necessary to have a second alarm control center and automatic response to alarms.

The two main system configuration concepts are **HWS** configuration, **CMS RS485** configuration and **CMS Delta Modulation** configuration.

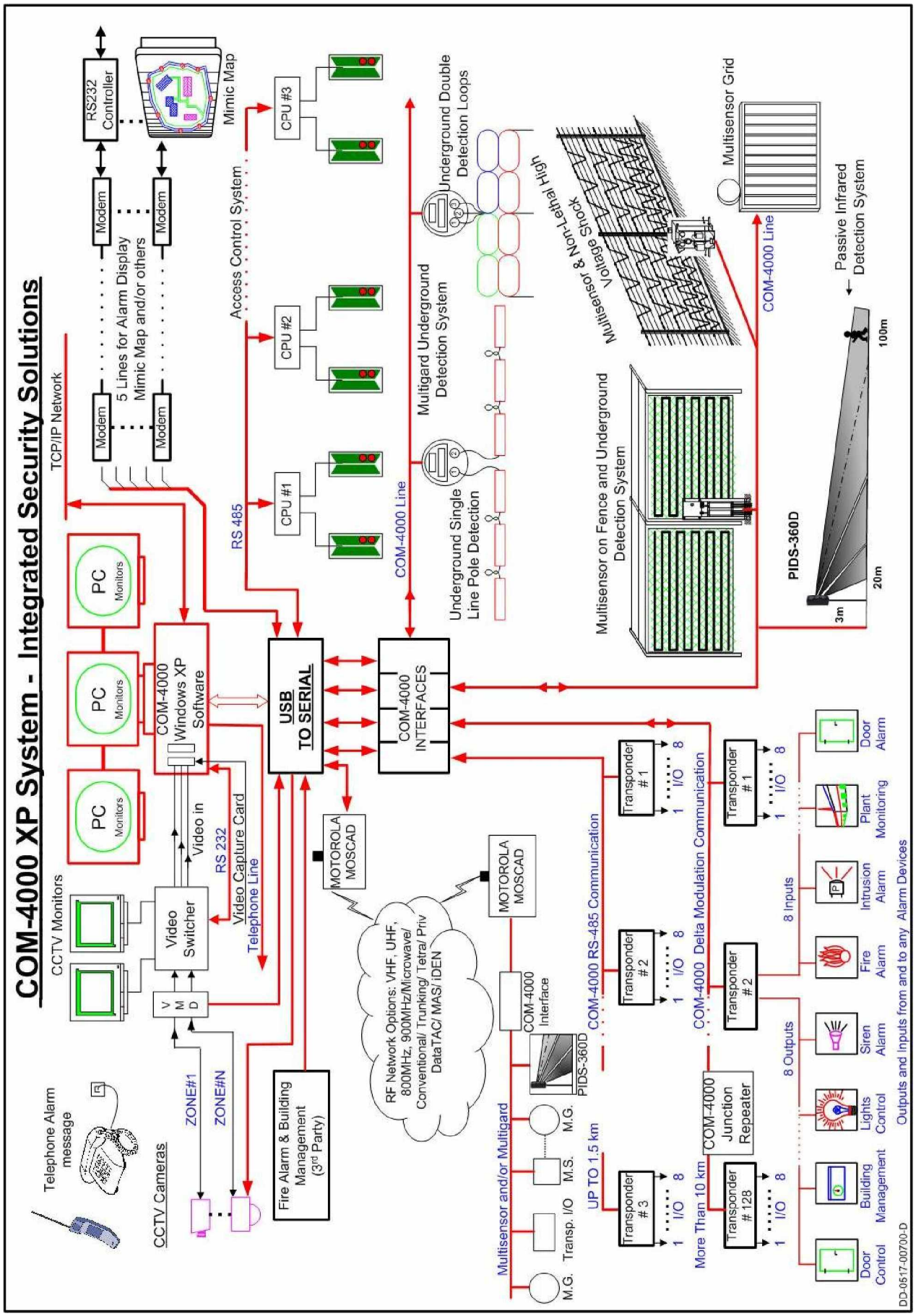
- **HWS Control Center Configuration**

  In **HWS** configuration the relay output coming from the HWS **Field Unit** can be interfaced with any standard alarm panel that can accept dry contact alarm relays and suitable to accept outdoor detectors..
  In case of a system where the distance of control room is above **200 m'** a special interface HWS communication unit have to be added to prevent false alarms from any **EMI disturbance**, coming from data cable.

- **CMS Control Center Configuration**

  The **Multigard-2000 CMS** configuration is based on **Com-4000 XP** system, the comprehensive, computerized security control system.
  The **Com-4000 XP** is operated on an **PC**, with dedicated software and graphic display.

  The control center receives alarm signals from the communication located in the **FU's** via the underground communication cable. All data transmitted from the **FU's** and into the **FU's** are multiplexed into two twisted pairs of wires (Delta modulation) or one twisted pair of wires for RS-485 COM4000 communication.
  The COM4000XP System have the capabilities to integrate the Multigard System with many other security systems as described in the following diagram.


COM-4000 XP System - Integrated Security Solutions
TCP/IP Network
RS232 Controller
Mimic Map
Modem
5 Lines for Alarm Display
Mimic Map and/or others
Access Control System
CPU #1
CPU #2
CPU #3
RS 485
COM-4000 Line
Multigard Underground Detection System
Underground Double Detection Loops
Underground Single Line Pole Detection
Multisensor & Non-Lethal High Voltage Shock
Multisensor Grid
Passive Infrared Detection System
PIDS-360D
3m
20m
100m
Multisensor on Fence and Underground Detection System
PC Monitors
COM-4000 Windows XP Software
USB TO SERIAL
COM-4000 INTERFACES
CCTV Monitors
Video Switcher
V M D
Video in
RS 232
Video Capture Card
Telephone Line
Telephone Alarm message
CCTV Cameras
ZONE#1
ZONE#N
Fire Alarm & Building Management (3rd Party)
MOTOROLA MOSCAD
RF Network Options: VHF, UHF, 800MHz, 900MHz/Microwave/ Conventional/ Trunking/ Tetra/ Priv DataTAC/ MAS/ iDEN
COM-4000 Interface
PIDS-360D
COM-4000 RS-485 Communication
UP TO 1.5 km
Multisensor and/or Multigard
M.G.
M.S.
Transp. I/O
Transponder # 1
Transponder # 2
Transponder # 3
Transponder # 128
1 I/O 8
COM-4000 Delta Modulation Communication
More Than 10 km
COM-4000 Junction Repeater
8 Inputs
8 Outputs
Door Alarm
Plant Monitoring
Intrusion Alarm
Fire Alarm
Siren Alarm
Lights Control
Building Management
Door Control
Outputs and Inputs from and to any Alarm Devices
DD-0517-00700-D

14. Inhibitor

The inhibitor unit have a single detection channel which is identical to the **FU** detection channel enable the **inhibitor** with special loop to pick up electrical or magnetic disturbing signals coming from the global environment.
When interference is detected by the inhibitor, it temporarily **disables** all alarm channels for two seconds, thus preventing a false alarm.
The inhibitor can be linked to the system at any point along the data cable .
The inhibitor can be controlled from the central to define sensitivity and mod of operation as **FU** through the **Com-4000 XP** transponder.
The inhibitor is required only in a large system. It's location depends on the geographical condition, in general one inhibitor covers about 5 k"m.

15. Maintenance Equipment

The maintenance of the system is done by a dedicate computerized test unit **Type 1MTSU120** or **Type 1MTSU140**.

This test unit is PC based. All functions and test procedures describe in document **MN-0522-45013-C (MULTIGARD TEST UNIT USER GUIDE)**.

The field maintenance is very simple with minor activity.

The **sensor cable** and **data cable** are grantee for long life. Both are armored cables and are immune from rodents and pests. The cable can be purchase from local producer according to the local quality standards.

Inadvertent cutting of the underground cables can be repaired by simple rejoining of cable wire and armored, covering it with a potting material.

All FU's and other electronic units are 100% interchangeable, so a faulty unit can be replaced by spare parts. Test will be done by the test unit and detection parameter setup is done automatically by the software, according to the previous last storage in computer database.