

SAT DIVIMOD

QAM Modulator Unit ***Coffret Modulateur MAQ***

PQM 2100

User's Guide

Guide Utilisateur

UG (GU) - N° N56714640101

Issue April 1997

Edition Avril 1997



FOREWORD

SAT reserves the right to modify the characteristics of its product without notice to take advantage of technical improvements. This guide is subjected to various technical developments and may be modified at any time without notice.

This guide consists of two parts:

- the first one in English marked "UG" on all pages,
- the second one in French marked "GU" on all pages.



AVANT-PROPOS

Les informations figurant dans ce guide sont soumises aux différentes évolutions techniques, la SAT se réserve le droit de modifier les caractéristiques de ses produits pour les faire bénéficier de perfectionnements techniques.

Ce guide comprend 2 parties :

- la première en Anglais marquée "UG" sur toutes les pages,
- la deuxième en Français marquée "GU" sur toutes les pages.

CAUTION

THE DEVICE MUST BE CONNECTED TO MAINS VIA A DIFFERENTIAL CIRCUIT-BREAKER.
UNAUTHORIZED MODIFICATIONS VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

THIS UNIT MUST NOT BE CONNECTED TO AN I.T. MAIN POWER.

UL LISTING VALID ONLY FOR 120 V.

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:

- 1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND,
- 2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRE OPERATION.

NOTE: This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communication.

Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

IMPORTANT

L'EQUIPEMENT DOIT ÊTRE RACCORDE A L'ALIMENTATION PRINCIPALE PAR L'INTERMEDIAIRE D'UN CIRCUIT DIFFERENTIEL.

TOUTE MODIFICATION DU PRODUIT DECHARGE LE FABRICANT DE TOUTE RESPONSABILITE.

CE COFFRET N'EST PAS RACCORDABLE A UN RESEAU I.T.

HANDBOOK CHANGE LIST

REPertoire DES MISES A JOUR

(A new edition replaces any previous versions)
(Une nouvelle édition annule et remplace les précédentes)

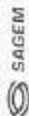


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01	April 1997	Creation of original User's Guide	All pages
01	Avril 1997	Création du Guide Utilisateur à l'édition originale	Toutes pages

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LIST OF ABBREVIATIONS

BB	Baseband
BER	Bit Error Rate
CATV	Cable TeleVision
Clk	Clock
DVB	Digital Video Broadcasting
FCC	Federal Communication Commission
Ft Ind	Fault Indication
I ² C®	Communications Bus designed by PHILIPS
IF	Intermediate Frequency
LAN	Local Area Network
LO	Local Oscillator
LVDS	Low Voltage Differential Signaling
Maj Alm	Major Alarm
Min Alm	Minor Alarm
MPEG2	Moving Pictures Experts Group
MPEG2-TS	MPEG2 - Transport Stream
PLL	Phase Locked Loop
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
Sym. Clk	Symbol Clock
TCM	Trellis Coded Modulation
TS	Transport Stream
TV	TeleVision
UL	Under Writers' Laboratories



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SECTION 1

INTRODUCTION



1 - INTRODUCTION

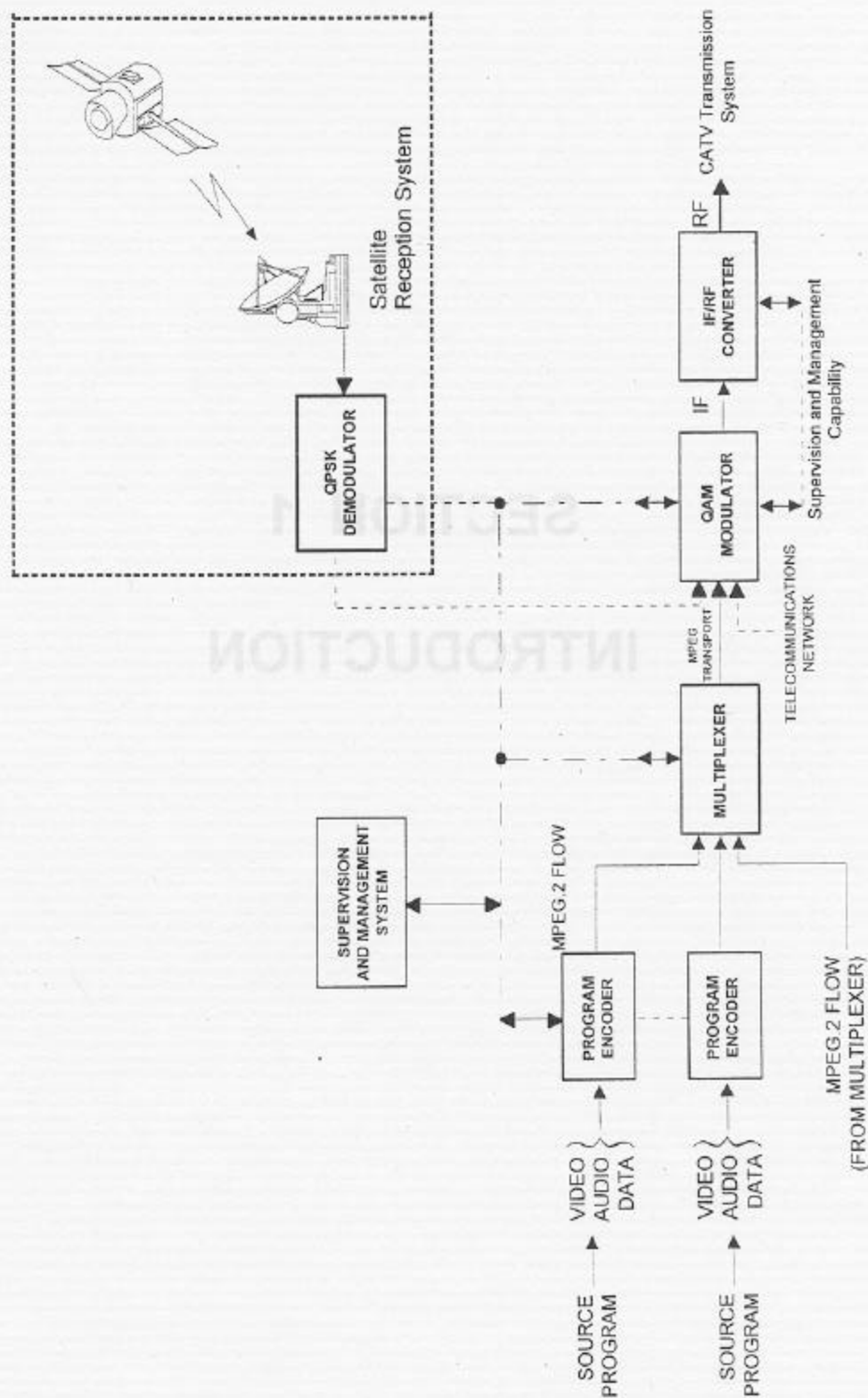


Figure 1.1 - Example of Use of the PQM 2100 Unit in a CATV Transmission System

1.1 - Introduction

The QAM PQM 2100 Unit is available in two equipment versions which mainly differ in their INR input interface:

PQM2100 ASI Rx Interface, 34 or 45 Mbit/s G.703 Interfaces

PQM2100-M2P M2P Rx Interface (RS422).

The PQM 2100 QAM Modulator has been designed for digital TV signal transmission over cable networks (fig. 1.1). It provides channel encoder and QAM modulator functions in full compliance with DVB recommendations, including the following operations:

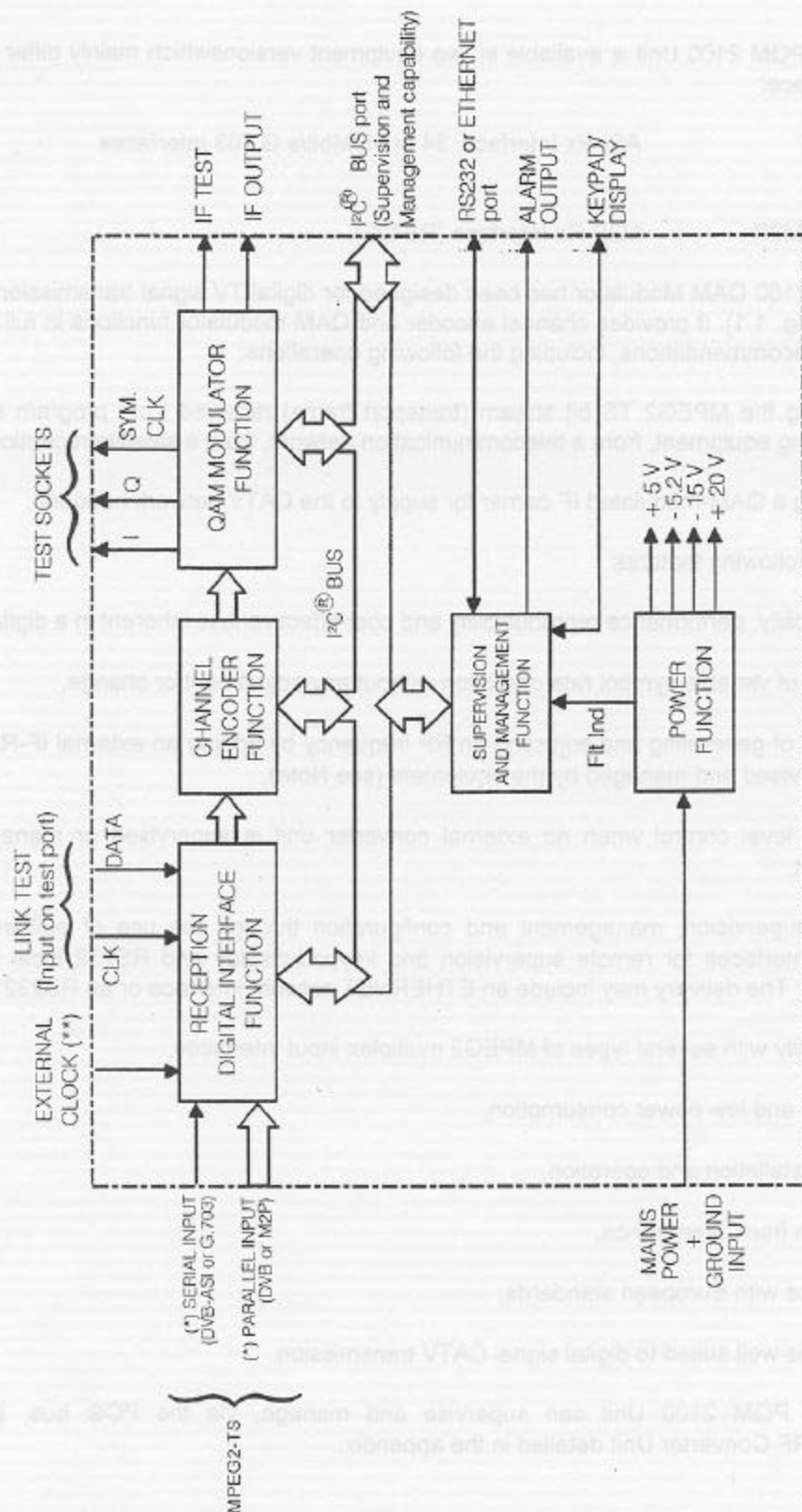
- processing the MPEG2 TS bit stream (transport frame) received from program encoding or multiplexing equipment, from a telecommunication network, from a satellite reception.
- generating a QAM-modulated IF carrier for supply to the CATV network headend.

Due to the following features:

- high reliability, performance reproducibility and cost-effectiveness inherent in a digital system,
- capability of variable symbol rate operation without any adjustment or change,
- possibility of generating and adjusting an RF frequency by adding an external IF-RF converter unit supervised and managed by the equipment (see Note),
- IF output level control when no external converter unit is supervised or managed by the equipment,
- ease of supervision, management and configuration through the use of built-in (Ethernet) network interfaces for remote supervision and keypad/display and RS232 local supervisory interfaces. The delivery may include an ETHERNET network interface or an RS232 interface,
- compatibility with several types of MPEG2 multiplex input interfaces,
- small size and low power consumption,
- ease of installation and operation,
- protection from interference,
- compliance with European standards,

PQM 2100 is well suited to digital signal CATV transmission.

Note: The PQM 2100 Unit can supervise and manage, via the I²C® bus, an external IF-RF Converter Unit detailed in the appendix.



(*) When an M2P parallel interface is used, the DVB serial input and parallel input are not supplied

(**) Specific input due to the use of an M2P parallel interface

Figure 1.2 - PQM 2100 Unit Block Diagram

1.2 - Functional Description

The PQM 2100 QAM Modulator Unit comes in a 1-unit high 19-inch rack-mounting enclosure containing the following six modules (cards or units):

- Reception Digital Interface Card,
- DVB-QAM Encoder Card,
- QAM Modulator Card,
- Supervision and Management Card,
- I²C® Interface Card,
- Power Supply Unit.

RECEPTION DIGITAL INTERFACE

PQM2100

The Reception Digital Interface Card alternatively provides connection to:

- a telecommunication network (G.703 interface),
- encoding or multiplexing equipment via a parallel DVB interface or a serial DVB-ASI interface,
- a QPSK demodulator.

The Card is available in two different types depending on the desired interface:

34 or 45 Mbit/s compliance with ITU-T recommendation G.703, or DVB-compliant ASI.

The parallel DVB-based interface is supplied in all cases.

PQM2100-M2P

The Reception Digital Interface Card provides connection of the PQM 2100-M2P Unit to encoding or multiplexing equipment through the proprietary M2P (RS422) parallel interface.

DVB-QAM ENCODER

The DVB-QAM Encoder Card provides channel encoding of the bit streams and associated clock signals transmitted by the Reception Digital Interface Card. Bit streams are encoded in compliance with DVB recommendations for transmission to the QAM modulator function.

The DVB-QAM Encoder Card functions include:

- energy dispersal (scrambling),
- forward error correction (Reed/Solomon),
- interleaving,
- differential inner encoding,
- mapping into QAM symbols.

1 - INTRODUCTION

QAM MODULATION

The QAM Modulator Card provides square-root Nyquist filtering in compliance with DVB recommendations, and amplitude modulation of two carriers in phase quadrature (QAM).

Three types of cards can perform this function:

- QAM - IF Modulator card = 36 MHz - 5.5 to 7 Mbaud,
- QAM - IF Modulator card = 36.15 MHz - 5.5 to 7 Mbaud,
- QAM - IF Modulator card = 44 MHz - 4 to 5.2 Mbaud.

Note: In the case of the QAM - IF = 36 MHz Modulator card, three types of IF-RF Converter Units are available:

- VHF1 IF-RF Converter Unit (108 - 240 MHz),
- VHF2 IF-RF Converter Unit (240 - 470 MHz),
- UHF IF-RF Converter Unit (470 - 862 MHz),

SUPERVISION AND MANAGEMENT

The Supervision and Management Interface Card monitors the PQM 2100 Unit through processing of Fault indications (Flt Inds) supplied by the various PQM 2100 Cards. The corresponding major and minor alarms are transmitted through relay contacts.

Local configuration access to the PQM 2100 Cards is available via the front panel keypad/display or using a PC connected to the RS-232 interface. Remote configuration access can also be provided through an interface to a (Ethernet) LAN.

NOTE: One interface only (RS-232 or ETHERNET) is supported by each PQM 2100 Unit.

Test functions (see Sub-section 5.4) activated via the respective operating software options allow Unit and link supervision.

The I²C® bus supports communications between the various PQM 2100 subassemblies and the Management and Supervision Interface Card, as well as a IF-RF Converter unit in some cases (*). The IF/RF Converter connection is provided by a I²C® Interface card via the corresponding connector.

(*) An external IF-RF Converter Unit may or may not be supervised and managed by the equipment.

POWER SUPPLY

The Power Supply Unit produces the tertiary voltages necessary for operation of the PQM 2100 Cards from the mains power supply (230-240 VAC or 120 VAC).

1.3 - Specifications

1.3.1 - Mechanical Specifications

Height	44 mm,
Width	430 mm,
Width (including mounting brackets)	480 mm (19-inch rack-mount),
Depth	450 mm,
Standard	ETS300.019 part 2 (CSEI13-10),
Weight	Less than 7 kg.

1.3.2 - Electrical Specifications

1.3.2.1 - Main Specifications

To DVB recommendations:

Modulation type	M-QAM, M= 16, 32, 64, 128 or 256,
Filter type	Square-root Nyquist or Full Nyquist (test),
Roll-off factor	0.15 or 0.13,
Symbol rate (Ds)	5.5 to 7 MBd (channel bandwidth = 7 or 8 MHz), 4 to 5.2 MBd (channel bandwidth = 6 MHz),
External code	RS (204, 188, 8),
Interleaving	Convolutional, Forney type, Depth I = 12,
Differential Inner Code	DVB with no TCM DAVIC with TCM
Inner code (switchable ON/OFF)	DAVIC Trellis, 4D, 16 States, Rate $R = \frac{[2\text{Log}_{(2)} M] - 1}{2\text{Log}_{(2)} M}$ R=1 with no TCM
Energy dispersal	Following DVB recommendations,

Data rate
(MPEG-2 transport)

$$D \text{ (Mbit/s)} = 188/204 \times \log_2 M \times D_s \text{ (Mbaud)},$$

Bit Rate (with RS)

$$D \text{ (Mbit/s)} = \log_2 M \times R \times D_s \text{ (Mbaud)}.$$

1.3.2.2 - Data Interface

Parallel interface

Complies with DVB recommendations.

Level

LVDS

Format

MPEG.2 transport (204 bytes),

Connector type

25-pin female HE 501
(on rear panel).

or

M2P Parallel interface

It is the M2P type (RS422).

Format

MPEG.2 transport (204 bytes),

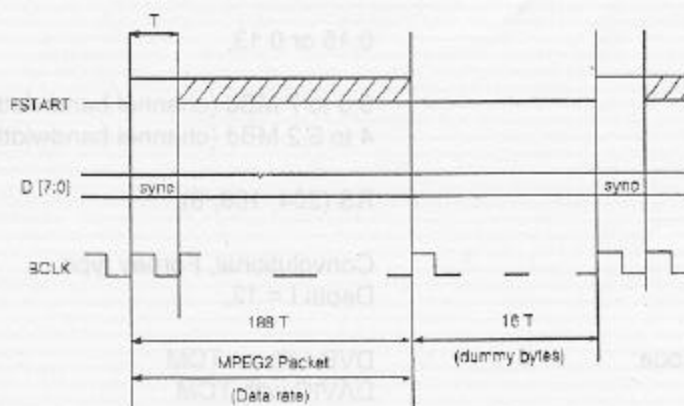
Impedance

100 Ω ,

Connector type

25-pin female HE 501 on rear panel).

The parallel input interface timing is given in figure below.



sync 47 hex

D7 = MSB

D0 = LSB

$$1 \text{ EXTCLK} = 8 \times 1 \text{ OUTCLK} = 8 \times 1 \text{ BCLK}$$

ASI Serial Interface

Complies with DVB recommendations.

Impedance	75 Ω
Connector type	Female BNC (on rear panel).
or	

34 Mbit/s Serial Interface

Complies with ITU-T recommendation G.703 (HDB3).

Impedance	75 Ω
Line rate	34 Mbit/s,
Max. useful rate	33.96525 Mbit/s (see Sub-section 4.3.3.1 - Bit rate)
Connector type	Female BNC (on rear panel).
or	

45 Mbit/s Serial Interface

Complies with ITU-T recommendation G.703 (HDB3).

Impedance	75 Ω
Line rate	45 Mbit/s,
Max. useful rate	44.21175 Mbit/s (see Sub-section 4.3.3.1 - Bit rate)
Connector type	Female BNC (on rear panel).

1.3.2.3 - External Clock Interface (only with M2P Int.)**Ext Clk Input**

Clock	Continuous
Impedance	75 Ω ,
Typical level	TTL
Connector type	Female BNC (on rear panel)

1.3.2.4 - Intermediate Frequency Interface

IF output

Connector type	Female BNC (on rear panel).
Frequency	36 MHz, 36.15 MHz, 44 MHz,
Impedance	75 Ω ,
Output Level (programmable in 1 dB steps)	Lo = -27 dBm to -7 dBm,

Note: In the case of supervision and management of an IF-RF Converter, the output level (Lo) is automatically programmed to -10 dBm by default.

1.3.2.5 - Test Signal Interface

The use of test signals is described in Sub-section 5.4.

IF Test Output

Frequency	36 MHz, 36.15 MHz, 44 MHz,
Impedance	75 Ω ,
Output Level	Lo -10 dB,
Connector type	Female BNC (on front panel).

Symbol Clock Test Output

Frequency	Sym. Clk,
Impedance	75 Ω ,
Level	TTL,
Connector type	Female BNC (on front panel).

I and Q Test Outputs

Impedance	75 Ω ,
Output pulse amplitude	$\approx$ 250 mVpp,
Connector type	Female BNC (on front panel).

Link Test Input Clock

Clock	Continuous,
Impedance	75 Ω ,
Level	TTL,
Connector type	Female BNC (on rear panel).

Link Test Input Data

Impedance	75 Ω ,
Level	TTL,
Connector type	Female BNC (on rear panel).

1.3.2.6 - Alarm Interfaces

Major alarm (make = normal operation)	Two relay contacts,
Minor alarm (make = normal operation)	Two relay contacts,
Max. voltage	72 VDC,
Max current	50 mA,
Connector type (on rear panel).	9-pin male HE501

1.3.2.7 - Supervision and Management Interfaces**RS-232 interface**

Baud rate	9600 Bd,
Connector type	9-pin female HE501 (on rear panel).

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(Ethernet) LAN Interface

Connector type female RJ45 (on rear panel).

I²C® Interface

Connector type female RJ45 (on rear panel).

NOTE: One interface only (RS-232 or ETHERNET) is supported by each PQM 2100 Unit.

1.3.2.8 - Power Requirements

Mains input voltage	120 VAC or 230-240 VAC on request,
Mains power frequency	47 Hz to 63 Hz,
Power consumption	100 VA (for 120 VAC Power Supply option), 0,5 A (for 230-240 VAC Power Supply option),
Connector type	Male connector, 2 phases + ground (on rear panel).

1.3.3 - Environmental

Temperature

To recommendation ETS300.019, Part 2 (CSE I11-10) with the following features:

Ambient temperature range	+ 5°C to + 45°C,
Relative humidity	≤ 95% at 25°C,
Storage temperature range	- 20°C to + 70°C,

Electromagnetic Compatibility

Conducted and radiated interference	To NF-EN 55022 Class B, NF-EN 50081-1 and CSE I12-10 and FCC Part 15A,
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Electrostatic Discharge

To recommendations NF-EN 55022, NF-EN 50082-1, IEC 801-2, and CSE I16-10 with the following features:

Level 2 (4 KV)	normal operation,
Level 3 (8 KV)	no irreversible degradation,
Level 4 (15 KV)	no component deterioration.

Electrical Safety and Dielectric Strength

To recommendation NF-EN 60950/A3 (IEC 950), NF-EN 601010, NF-EN 41003 and UL 1419.

All electrical ports include SELV type safety provisions. The 230-240V/120V port and the associated mains power cable are the « dangerous voltage » type.

When the Unit is equipped with an ETHERNET card, the latter can only be connected to a standard ETHERNET port complying with Safety Extra Low Voltage (SELV) provisions.

Susceptibility

Radiated susceptibility	To IEC 801-3 (level 2),
Electrical fast transients	To IEC 801-4 (level 2) and CSE I19-10,
Immunity from shock waves	To IEC 801-5 (level 2).

Power Supply Access

To recommendation NF-EN 60950/A3, CSE I23-10 and UL 1950.

Acoustical

To recommendation CSE I15-10.

Note: UL compliance is applicable to the 120 VAC versions only, whereas compliance with French and European standards is applicable to the 230-240 VAC versions.

1 - INTRODUCTION

1.3.4 - Bit Rate Range Depending on QAM Modulation Type, Modulator Symbol Rate Range and TCM mode

α = Roll-off factor
 BW = User band
 D' = Bit rate

Ds = Symbol rate

D = Data rate

Symbol Rate in MBaud (Ds)	Bit Rate (D' in Mbit/s with no TCM)				
	4	5.2	5.5	6.1	7
16-QAM (N=4)	16.0	20.8	22.0	24.4	28.0
32-QAM (N=5)	20.0	26.0	27.5	30.5	35.0
64-QAM (N=6)	24.0	31.2	33.0	36.6	42.0
128-QAM (N=7)	28.0	36.4	38.5	42.7	49.0
256-QAM (N=8)	32.0	41.6	44.0	48.8	56.0
BW = 6 MHz					
BW = 7 MHz					
BW = 8 MHz					

Table 1 - Bit Rate D' (Mbit/s) including RS (204,188) with no TCM

Symbol Rate in MBaud (Ds)	Bit Rate (D' in Mbit/s with TCM)				
	4	5.2	5.5	6.1	7
16-QAM (N=4)	14.0	18.2	19.25	21.35	24.5
32-QAM (N=5)	18.0	23.4	24.75	27.45	31.5
64-QAM (N=6)	22.0	26.8	30.25	33.55	38.5
128-QAM (N=7)	26.0	33.8	35.75	39.65	45.5
256-QAM (N=8)	30.0	39.0	41.25	45.75	52.5
BW = 6 MHz					
BW = 7 MHz					
BW = 8 MHz					

Table 2 - Bit Rate D' (Mbit/s) including RS (204,188) with TCM

Symbol Rate in MBaud (Ds)	Data Rate (D in Mbit/s with no TCM)				
	4	5.2	5.5	6.1	7
16-QAM (N=4)	14.7	19.2	20.3	22.5	25.8
32-QAM (N=5)	18.4	24.0	25.3	28.1	32.3
64-QAM (N=6)	22.1	28.8	30.4	33.7	38.7
128-QAM (N=7)	25.8	33.5	35.5	39.4	45.2
256-QAM (N=8)	29.5	38.3	40.5	45.0	51.6

Table 3 - Data Rate D (MPEG2 Transport Layer) (Mbit/s) with no TCM

Symbol Rate in MBaud (Ds)	Data Rate (D in Mbit/s with TCM)				
	4	5.2	5.5	6.1	7
16-QAM (N=4)	12.9	16.7	17.7	19.6	22.5
32-QAM (N=5)	16.5	21.5	22.8	25.3	29.0
64-QAM (N=6)	20.3	26.3	27.9	30.9	35.5
128-QAM (N=7)	23.9	31.1	32.9	36.5	41.9
256-QAM (N=8)	27.6	35.9	38.0	42.1	48.4

Table 4 - Data Rate D (MPEG2 Transport Layer) (Mbit/s) with TCM

$$D' = \log_2(M) \cdot R \cdot D_s \text{ where } M = 2^N$$

$$D = D' \cdot 188/204$$

$$D_s = BW / (1 + \alpha) \quad \rightarrow \quad D_s = 5.2 \text{ MBaud (where } \alpha = 0.15 \text{ and } BW = 6 \text{ MHz)}$$

1 - INTRODUCTION

The various (PQM 2100) Modulator Unit configurations are used depending on particular constant symbol rate requirements (4 to 5.2 Mbaud or 5.5 to 7 Mbaud). Therefore, constellation pattern(s) 1 or 2 may be used as shown in figures 1.3 to 1.6 below at a given user rate. When the user rate corresponds to two constellation patterns, the software allows the operator to select the modulation best suited to his requirements.

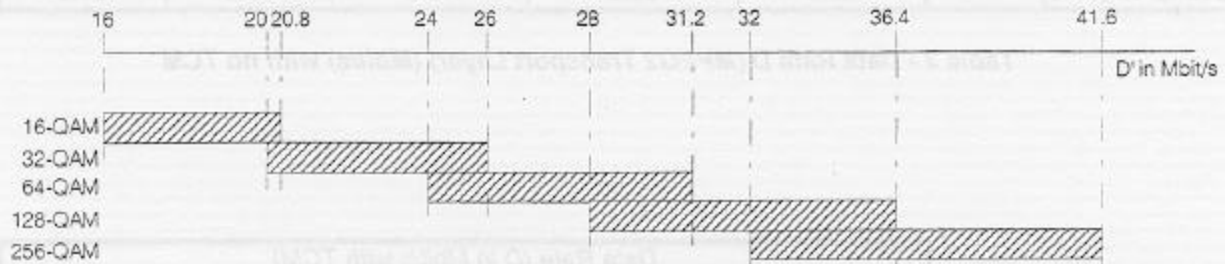


Figure 1.3 - QAM Modulator Bit Rate Ranges Depending on Modulation Type for $4 \leq D_s \leq 5.2$ Mbaud with no TCM

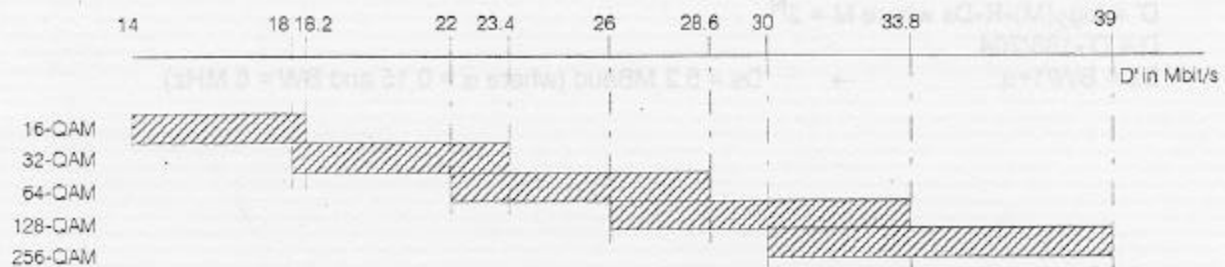


Figure 1.4 - QAM Modulator Bit Rate Ranges Depending on Modulation Type for $4 \leq D_s \leq 5.2$ Mbaud with TCM

Where D' = Bit rate in Mbit/s
 D_s = Symbol rate in Mbaud
 M = Modulation type

$$D' = \log_2(M) \times D_s$$

$$M = 2^N$$

M values: 4, 5, 6, 7, 8

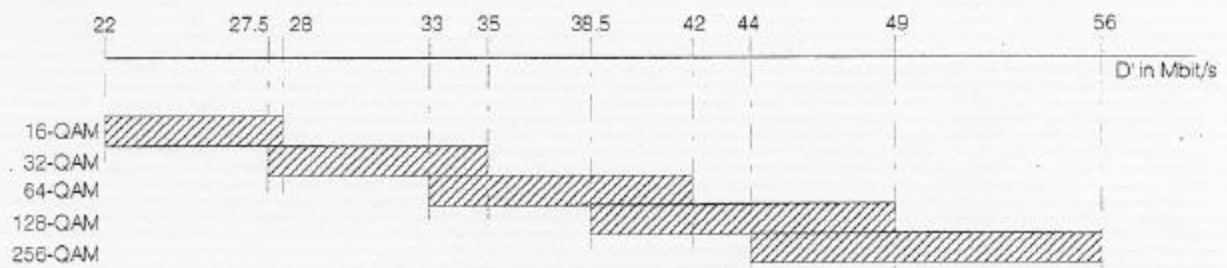


Figure 1.5 - QAM Modulator Bit Rate Ranges Depending on Modulation Type for $5.5 \leq D_s \leq 7$ Mbaud with no TCM

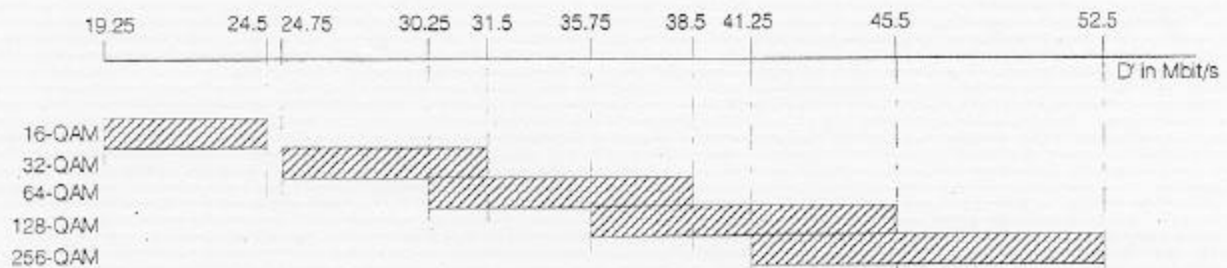


Figure 1.6 - QAM Modulator Bit Rate Ranges Depending on Modulation Type for $5.5 \leq D_s \leq 7$ Mbaud with TCM

Where D' = Bit rate in Mbit/s
 D_s = Symbol rate in Mbaud
 M = Modulation type

$$D' = \log_2(M) \times D_s$$

$$M = 2^N$$

M values: 4, 5, 6, 7, 8

SECTION 2

DESCRIPTION

The PQM 2100 Unit is contained in a 1-unit high enclosure fitted with two side 19-inch rack-mounting brackets. The front and rear panels are described below. Connector pin assignments are given in Section 3. Figure 2.1 is a general view of the PQM 2100 Unit.

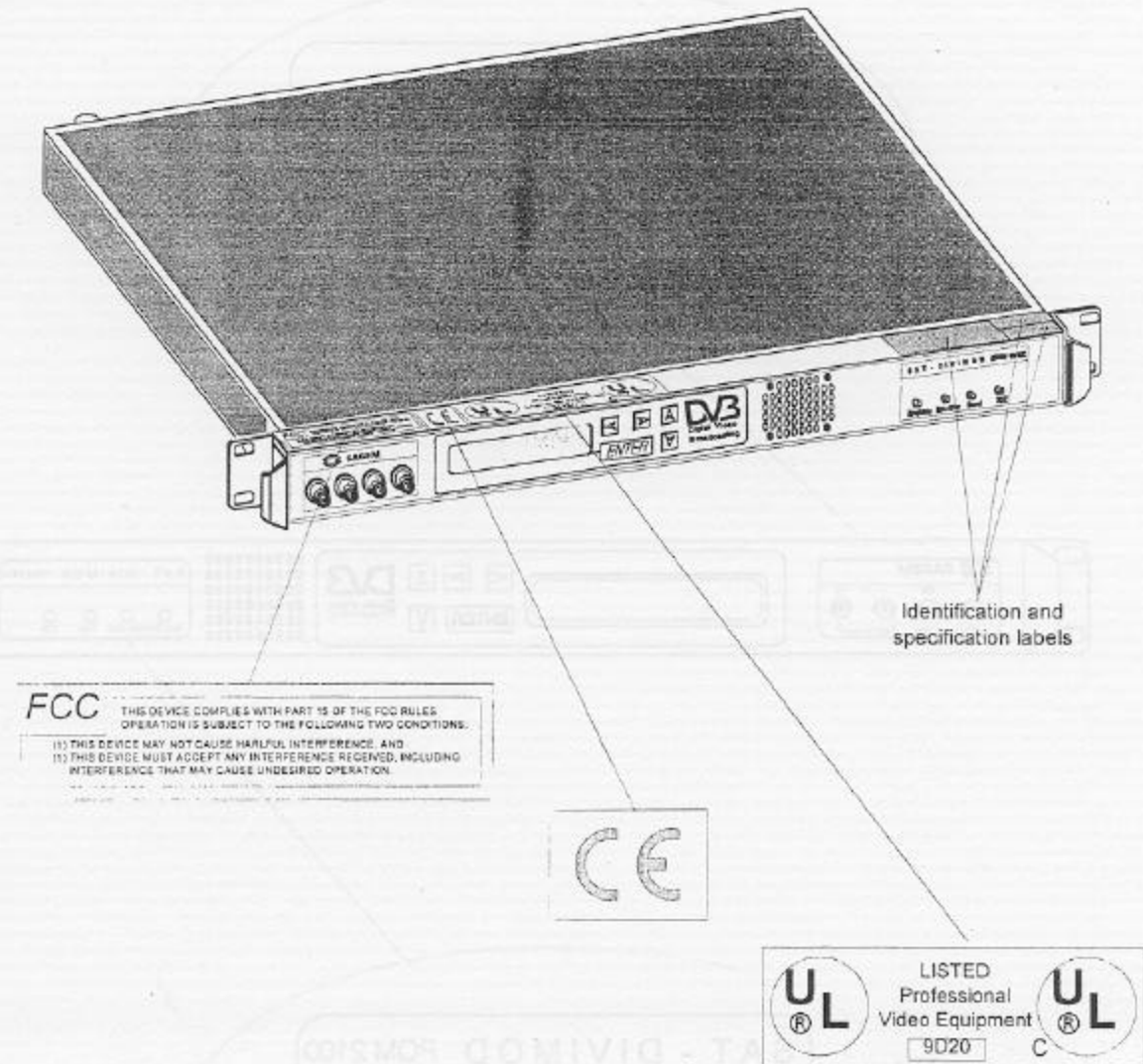


Figure 2.1 - PQM 2100 Unit

REMARK: SAT reserves the right to change Unit label positions to comply with current regulations in the countries in which the Unit is marketed.

2 - DESCRIPTION

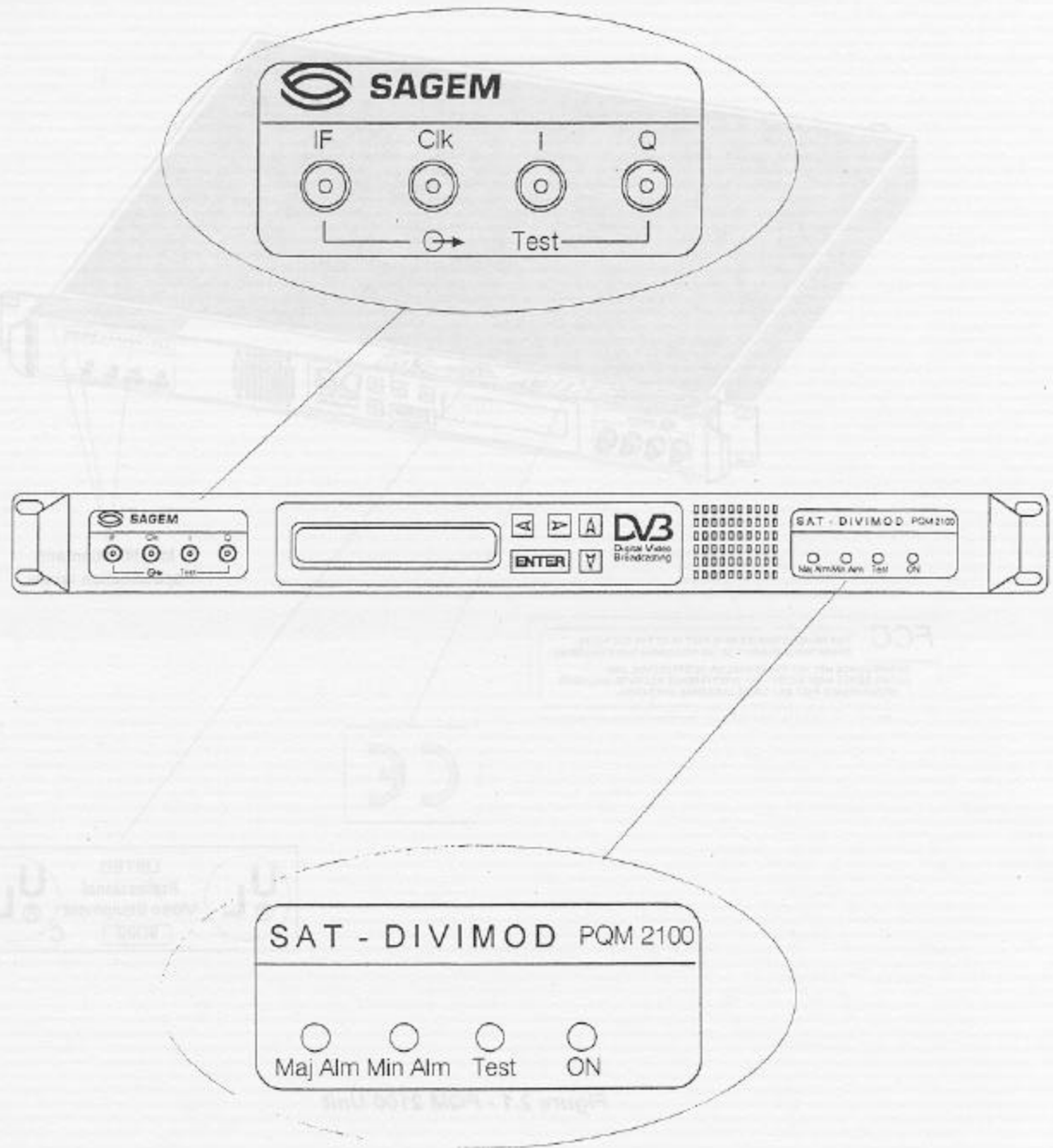


Figure 2.2 - PQM 2100 Unit Front Panel

2.1 - Front Panel

The front panel is identical for the two Unit types (PQM 2100 or PQM 2100-M2P).

The front panel consists of three sections (see figure 2.2):

In the left hand side section, the following four BNC connectors (see figure 2.2), from left to right:

- **IF** connector: modulated IF output test socket,
- **Clk** connector: symbol clock output test socket,
- **I** connector: baseband I output test socket,
- **Q** connector: baseband Q output test socket.

In the middle section, a keypad/display provides local control access to the PQM 2100 and PQM 2100-M2P Units. The display screen consists of two 24-character lines and the keypad has the following keys:

➤	Left (L)
➤	Right (R)
⬆	Up (U)
⬇	Down (D)
ENTER	Validate (V)

In the right hand side section, the following four LEDs:

- red **Maj Alm** LED indicating a major alarm condition (when lit: at least one major alarm),
- red **Min Alm** LED indicating a minor alarm condition (when lit: at least one minor alarm),
- yellow **Test** LED which, when lit, indicates that a test is in progress,
- green **ON** LED which, when lit, indicates that (230-240 VAC or 120 VAC) mains power is on, and when unlit, mains power or (+20 V) secondary voltage failure.

2 - DESCRIPTION

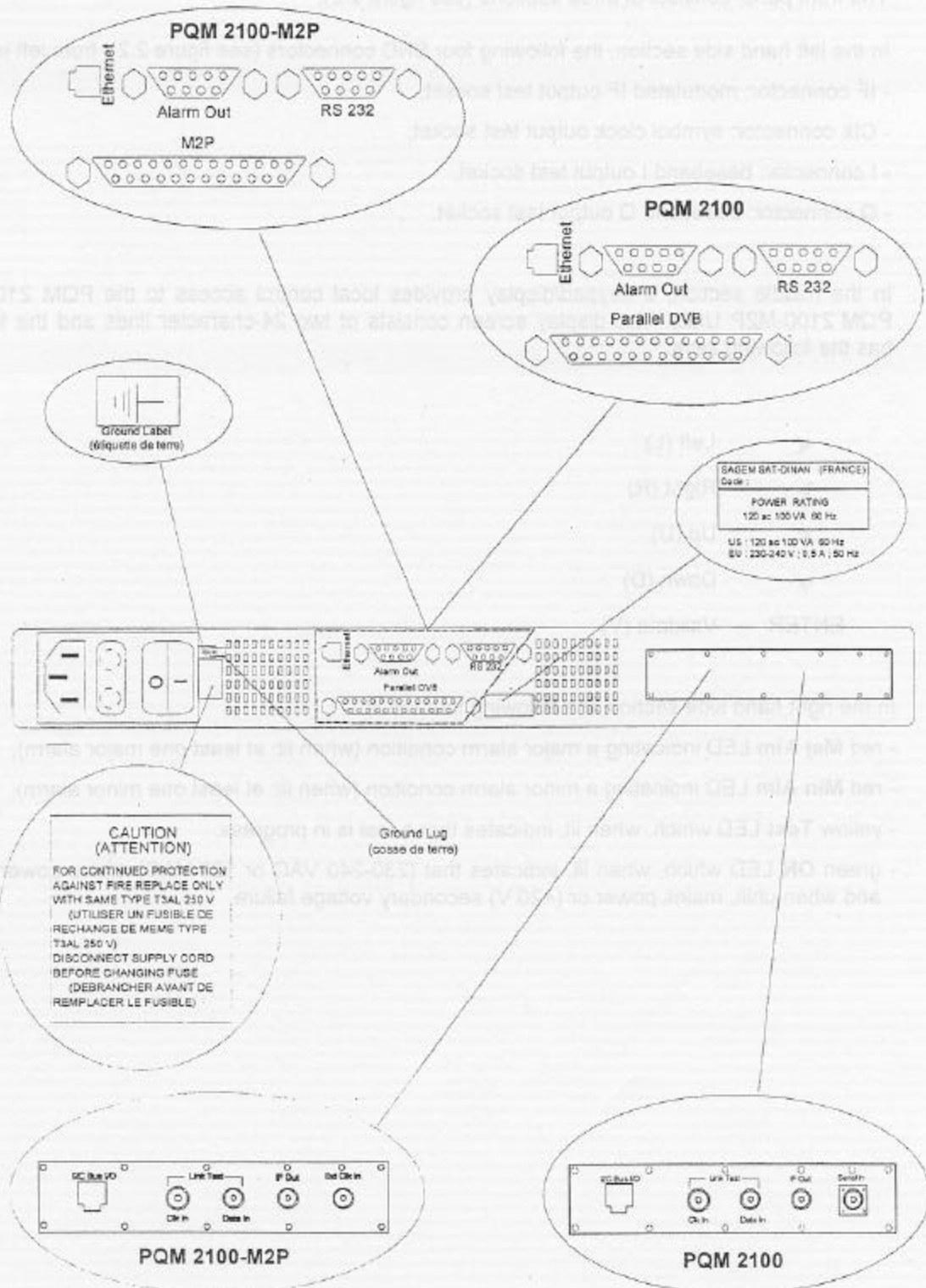


Figure 2.3 - PQM 2100 Unit Rear Panel

2.2 - Rear Panel

The rear panel depends on the Unit type (PQM 2100 or PQM 2100-M2P).

The rear panel consists of three sections (see figure 2.3).

In the left hand side section:

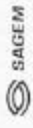
- (male, 2-phase + ground) power connector (IEC connector),
- fuse holder containing two 3 Amp delay fuses (Part No. HA20T3A) protecting each phase,
- ON/OFF (I/O) switch for switching the PQM 2100 Unit on,
- caution label for fuse removal,
- a lug for grounding the Unit to chassis ground and the corresponding graphic symbol label on the Unit rear panel next to the lug.

In the middle section, the following four connectors:

- female RJ45 connector marked **Ethernet**: provides connection to a (Ethernet) LAN,
 - 9-pin HE 501 male connector marked **Alarm Out**: Alarm port,
 - 9-pin HE 501 female connector marked **RS 232**: provides connection to a PC,
 - 25-pin HE 501 female connector marked **Parallel DVB**: Parallel DVB input port,
- or
- 25-pin HE 501 female connector marked **M2P**: M2P parallel input port (RS-422),
- and an identification label (see figure 2.3).

In the right hand side section, the following five connectors:

- female RJ45 "I2C I/O Bus" connector, which may be used via an I²C® Bus interface for IF-RF converter supervision and management,
 - "Clk In" 75 Ω BNC connector used for the maintenance link test (data on TEST IN),
 - "Data In" 75 Ω BNC connector used for the maintenance link test (data on TEST IN),
 - "IF Out" 75 Ω BNC connector delivering the modulated IF output,
 - 75 Ω BNC female connector marked **Serial In**, isolated from the ground, and providing connection to the DVB serial input or 34 Mbit/s G.703 input,
- or
- 75 Ω BNC female connector marked **Ext. Clk In**, and providing connection to the external clock for synchronization of the MPEG.2 frame carried by the M2P Rx Int Card.



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SECTION 3

INSTALLATION and START-UP

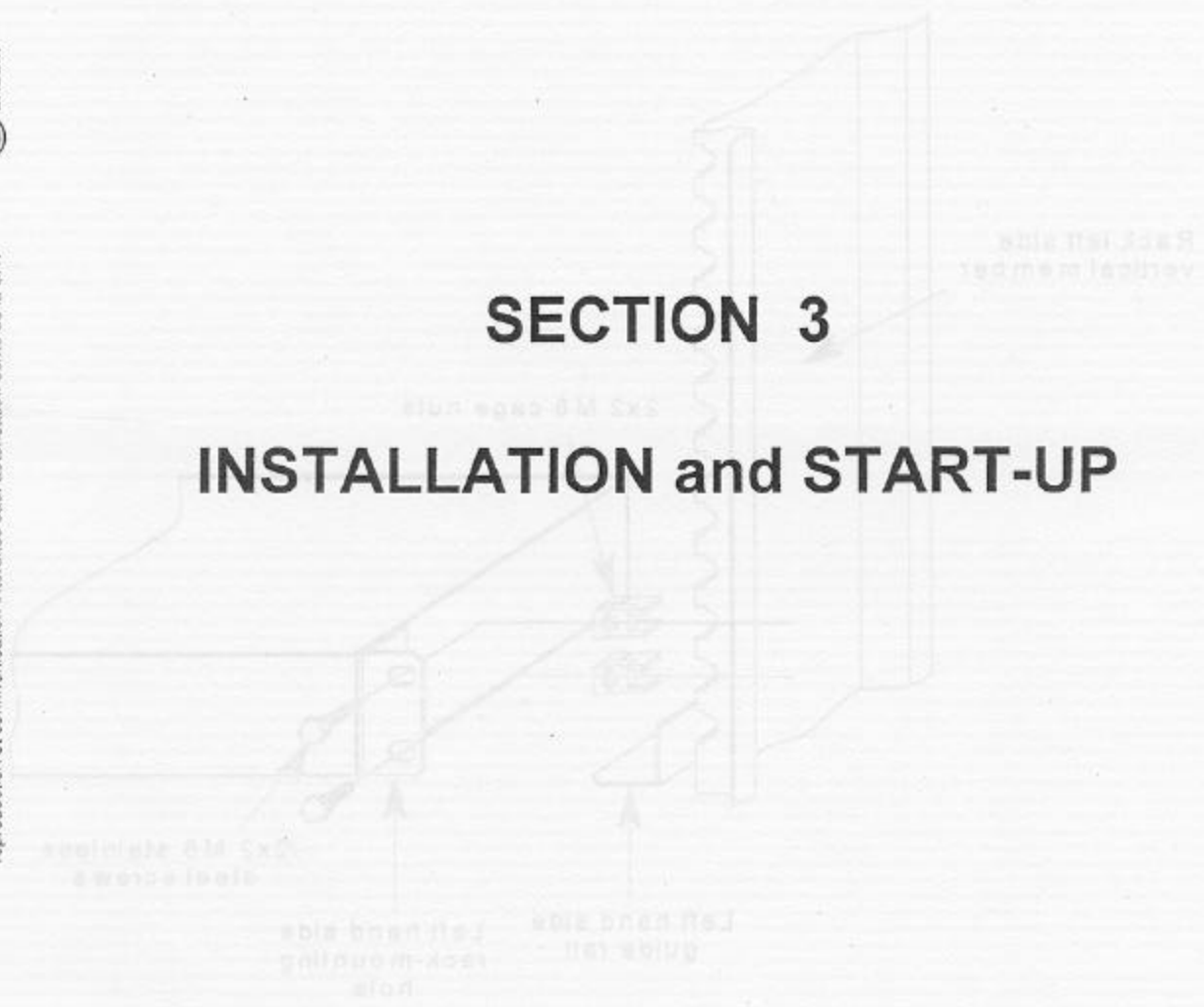


Figure 3-1 - PCM 2100 Unit 19-inch Rack-mounting

3 - INSTALLATION AND START-UP

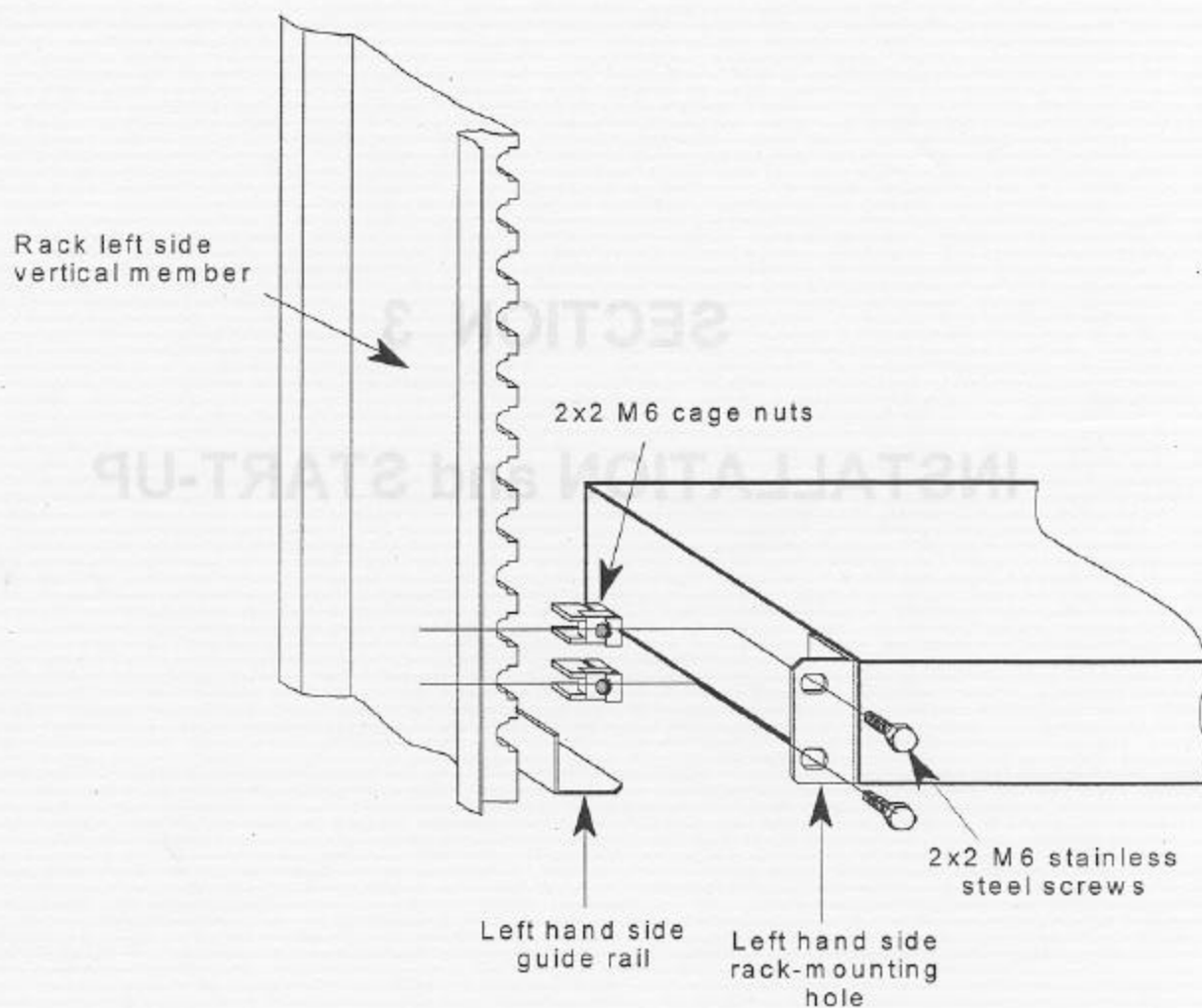


Figure 3.1 - PQM 2100 Unit 19-inch Rack-mounting