International Standard ISO 6551

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Petroleum liquids and gases — Fidelity and security of dynamic measurement — Cabled transmission of electric and/or electronic pulsed data

Liquides et gaz de pétrole — Fidélité et sécurité des mesures dynamiques — Systèmes de transmission par câbles de données, sous forme d'impulsions électriques et/ou électroniques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 6551 was developed by Technical Committee ISO/TC 28, *Petroleum products*, and was circulated to the member bodies in May 1981.

It has been approved by the member bodies of the following countries :

Australia	Israel	South Africa, Rep. of
Austria	Italy	Spain
Brazil	Japan	Sweden
Canada	Korea, Rep. of	Switzerland
Egypt, Arab Rep. of	Mexico	Turkey
France	Netherlands	United Kingdom
Germany, F. R.	Norway	USA
Hungary	Peru	USSR
India	Poland	
Iran	Romania	

No member body expressed disapproval of the document.

Petroleum liquids and gases — Fidelity and security of dynamic measurement — Cabled transmission of electric and/or electronic pulsed data

0 Introduction

0.1 Quantitative measurements are required at many stages in production, transportation, refining and marketing of petroleum and its products. They form the basis of royalty, fiscal and custody transfer accounting and provide the means of stock and loss control.

The use of agreed standardized measurement equipment and procedures obviates disputes over quantities, enabling these to be determined with an accuracy mutually acceptable to all parties to a transaction and at the most economical cost for the method of measurement selected.

0.2 During the last decade there has been a rapid increase in the use of electrical or electronic data-transmission systems designed to facilitate the determination of physical quantities such as length, mass, volume, etc.

Such systems can be vulnerable to disturbances arising from the environment in which they are used, and also from functional failures, all or any of which may affect the integrity of the resulting measurement.

The purpose of this International Standard is to assist manufacturers and users of electrical or electronic pulsed data-transmission systems used in the metering of fluids to meet certain criteria for the design, installation, use and maintenance of such equipment. The object is to establish and maintain the credibility of indicated data against influences acting to impair the fidelity of the system.

0.3 This International Standard recommends solutions for fidelity and security problems which constitute good practice in this field at this time, but it is not claimed that the recommendations are wholly comprehensive.

The recommendations are, however, considered to be practicable, and to satisfy the immediate needs of industries associated with meter proving and the metering of hydrocarbons and hydrocarbon products in the bulk commercial, royalty metering, revenue accounting and custody transfer fields in general.

0.4 It is not intended that these recommendations should act to inhibit technological progress in the industry, and therefore amendments may be introduced as and when required.

The principles may be applied to the metering of solids.

0.5 Clauses have been included on safety and other precautions that constitute good practice.

Although every care is taken to include such clauses wherever necessary, it is impossible to cover all contingencies. In the designing of measurement and sampling operations, attention should also be given to general codes of safe practice for petroleum operations. The operator or other user of this measurement standard should work according to accepted safe practices and comply with all relevant regulatory requirements.

0.6 This International Standard is recommended for general adoption but it must therefore be read and interpreted in conjunction with legal metrology (weights and measures), safety and other regulations in force in a particular country in which it is intended to apply it.[1)]

1 Scope and field of application

1.1 General

This International Standard establishes guidelines for ensuring the fidelity and security of pulsed data cabled transmission systems utilized for the metering of fluids (see the note), a main objective being to ensure the integrity of the primary indication (see 2.2.5).

NOTE — Compliance with the requirements of this International Standard does not increase the basic precision of measurement, either in the electrical or electronic section of the system, or in the overall system which includes the meter(s).

1) In the case of marine applications, the safety requirements of the appropriate Ship Classification Society will apply. This includes offshore production facilities for which a Society has been appointed as the Certifying Authority for the compliance of the installation with official safety standards.

1.2 Levels of security

1.2.1 In order to achieve different levels of security (see the note and clause 3) which can be applied to such systems, criteria and recommendations for the design, installation, use and maintenance of the relevant equipment are laid down.

NOTE — The levels of security are designated E to A, from the lowest to the highest order of security respectively.

For the majority of applications, the lower levels are considered to be adequate and at the time of the publication of this International Standard, there is no known system for which Level A security is considered to be a necessity.

1.2.2 This International Standard does not define which levels of security are to be used for a particular system application.

1.3 Safety and regulatory requirements

1.3.1 Regulatory requirements, including those for safety, are not specifically covered in detail but certain general cautionary notes on safety are included for guidance (see the note).

NOTE — Compliance with this International Standard in no way absolves manufacturers and users of systems and equipment from meeting all relevant legal metrology (weights and measures), safety and other regulations applicable in the country in which it is intended to use a system. Special attention is drawn to 0.5 and 0.6 of the Introduction.

2 Definitions

2.1 In preparing this glossary, the following two principles have been followed :

a) To select for definition the minimum of basic terms used in the text and to apply to them an unequivocal meaning. It is recommended that these standardized terms, as defined, should be used in the context of the application of this International Standard.

b) To exclude other terms used in the text which are adequately defined elsewhere, or the meanings of which are self-evident.

2.2 For the purpose of this International Standard, the following definitions shall apply.

2.2.1 fidelity : The exactitude with which the primary indication reproduces the inherent precision of the measurement.

2.2.2 flow (rate or quantity) transducer : A device for converting the indication of flow (rate or quantity) to a usable output.

2.2.3 totalizer : A device which sums the indications of an indicating device; it may or may not be resettable to zero (see 4.4).

2.2.4 noise : Unwanted signals which may impair fidelity, and which occur for periods exceeding 0,2 s.

2.2.5 primary indication : The combination of the transducer(s) output(s), the transmission cabling, the signal conditioning, processing and scaling, and the indicator with or without totalizer and their readings, the whole of which produces the final reference for the transaction.

2.2.6 secondary indication (auxiliary or ancillary indication) : Any equipment which separately or in combination provides indication of the quantity measured, but which does not form part of the primary indication.

2.2.7 security : The state or means of ensuring fidelity. The degree or level of security given by a minimum basic arrangement, can be increased by additional equipment.

2.2.8 transients : Disturbances having a duration of 0,2 s or less.

2.2.9 pulse transmitter : A device for converting the output from a transducer into a pulsed signal of low source impedance over the full operating frequency range (with pre-amplification if necessary).

2.2.10 unrevealed error : Any lack of fidelity outside the prescribed limits of error, including errors caused by functional failure and by external influences.

3 Levels of security

3.1 Designation of security levels

In this International Standard, five levels of security are identified and designated, of which *Level E* represents the minimum acceptable level. Typical examples of these five levels are shown diagrammatically in figures 1 to 5, and are described below.

3.1.1 Level E

Error reduction is achieved solely by correctly installed apparatus of good quality.

This is a straightforward scaler totalizer system.

3.1.2 Level D

Manual error monitoring at specified intervals by methods of comparison.

This level of security is intended to give protection against functional errors and failures and is a method of verification by manual action. It has the means for checking the read-out visually against an independent totalizing system.

3.1.3 Level C

Automatic error monitoring and error indication at specified intervals by methods of comparison.

This level of security is intended to give protection against functional errors and failures and this may be achieved by design methods acceptable to an approving authority (if appropriate). The time intervals for error monitoring are subject to revision in the light of experience gained.

3.1.4 Level B

Continuous monitoring, error indication and alarm signalling by methods of comparison.

This level of security is intended to give *warning* of transients and other spurious influences, supply borne and radiated, in addition to functional errors and failures.

3.1.5 Level A

Continuous *verification* and *correction* by methods of comparison. Errors must be signalled even though they are corrected.

This level of security is intended to give *protection* against transients and other spurious influences, supply borne and radiated, in addition to functional errors and failures.

For this level of security, alternative transmission lines following two different routes should be provided, together with batteries for back-up power supply.

3.2 General note on security levels

3.2.1 A metering system may comprise sections having the same or different levels of security. Figures 1 to 5 show typical functional arrangements of modules required to achieve the specified levels of security.

3.2.2 In the examples, emphasis has been placed on the transmission system as this is considered to be the most vulnerable area of the whole.

3.2.3 Security for the scaler totalizer is not illustrated and is considered to be acceptable to *Level E* for the majority of applications.

It may, however, be considered necessary in some circumstances to duplicate the scaler and/or the totalizer section.

3.2.4 The factors contributing to the integrity of the functions are considered in clauses 4 to 8.

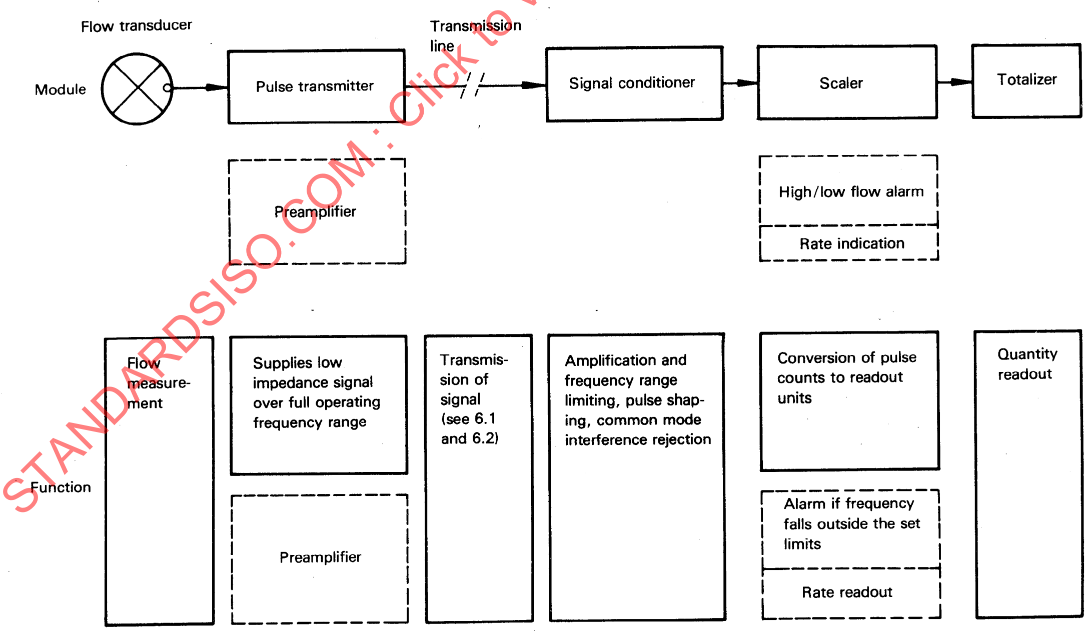

Figure 1 — Typical functional arrangement for pulse security system

Level E. The diagram illustrates a simple system with no built-in provisions for error monitoring. Only good quality components and sub-units, correctly installed, will lead to confidence in the security of the system. The use of a pre-amplifier transmitter to drive the transmission line is considered beneficial for the majority of applications, as is the provision of signal conditioning. The system, though simple, does not differ in hardware quality from more secure systems using the same elements. (Note that the modules and functions shown in full are essential. Those shown dotted are optional.)

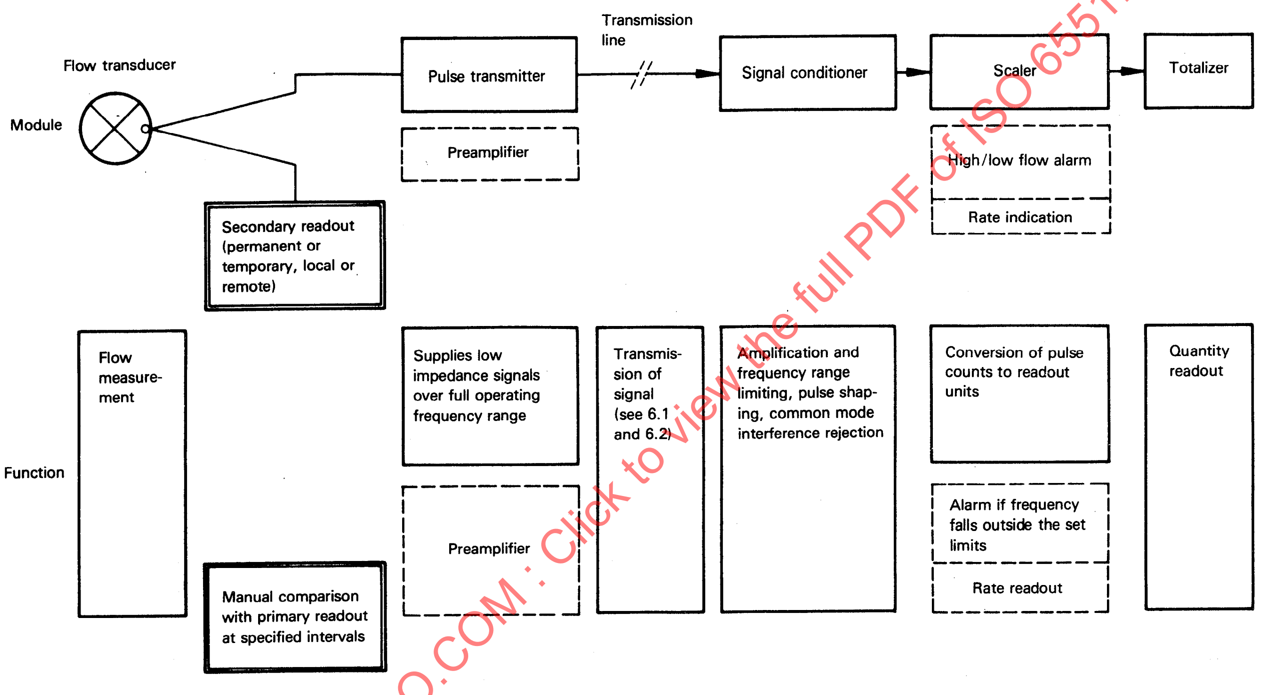

Figure 2 — Typical functional arrangement for pulse security system

Level D. The diagram illustrates a simple system with means of making a periodic manual assessment of security. The secondary readout may be permanent or temporary, local or remote. Manual comparison made during a periodic check will monitor the integrity of the transmission and totalizer elements. It may be less convenient than the provisions of Level C as the system may have to be stopped for readings to be taken. Overall security is mainly inferred from the performance during the error monitoring period. (Note that the modules and functions shown in full are essential. Those shown dotted are optional. The modules and functions boxed in double line indicate the difference from Level E).

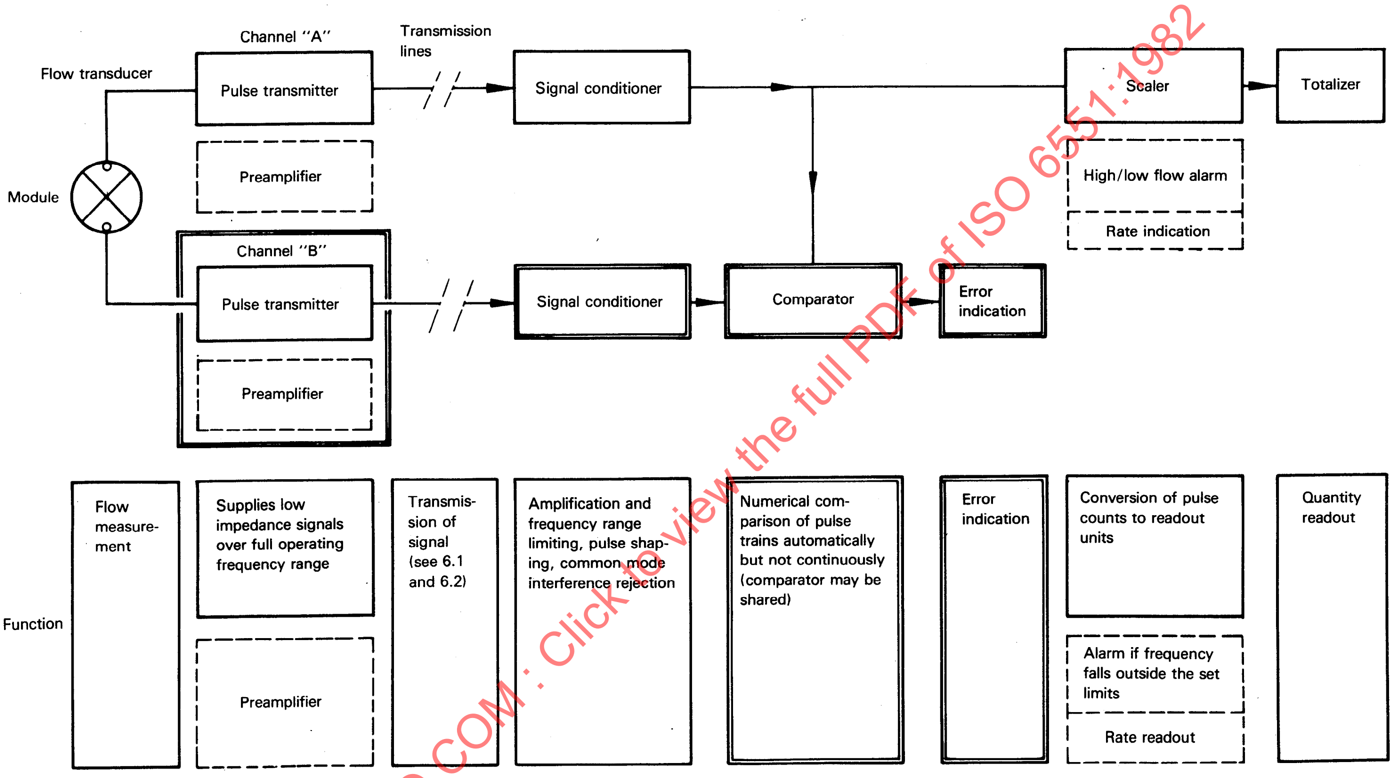

Figure 3 — Typical functional arrangement for pulse security system

Level C. The diagram illustrates a dual transmission system with a dual pulse comparator of simple design. If the pulses delivered become numerically out of step, warning will be given by the comparator (differential counter). Level C security will be defeated by other disturbances dealt with by higher level security systems, e.g. simultaneous interference superimposed on both channels will not be detected because a numerical difference between channels is not caused. It is intended that this form of error monitoring is carried out periodically, the monitoring equipment may thus be shared with other metering systems. Level C security is inferred from the results obtained during the monitoring period. (Note that the modules and functions shown in full are essential. Those shown dotted are optional. The modules and functions boxed in double line indicated the difference from Level D.)

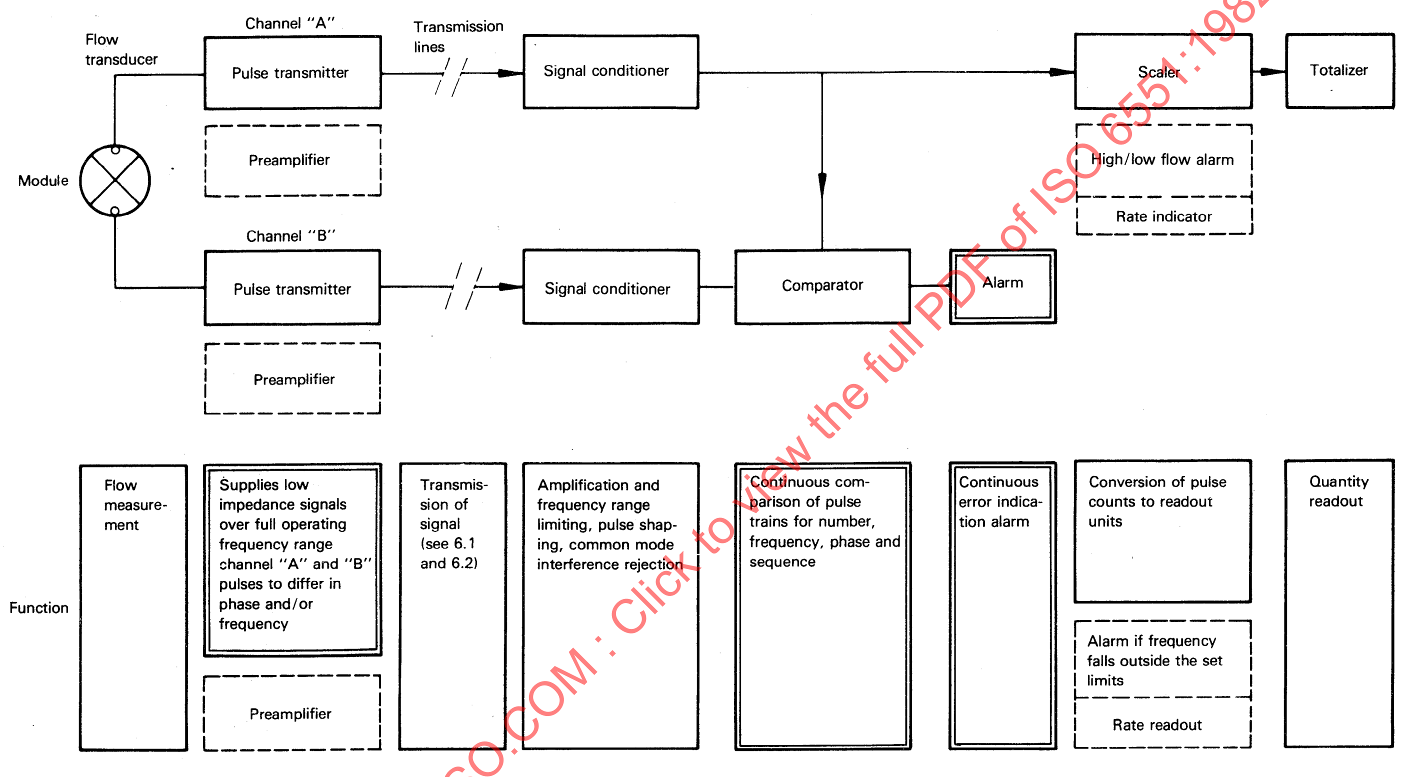

Figure 4 — Typical functional arrangement for pulse security system

Level B. The diagram illustrates a dual transmission system with a dual pulse comparator in which the pulse trains are continuously monitored for number, frequency, phase and sequence and any irregularity is indicated. Simultaneous interfering pulses must be detected and indicated. Alarm is given if pulses are lost or gained on either channel. (Note that the modules and functions shown in full are essential. Those shown dotted are optional. The modules and functions boxed in double line indicate the difference from Level C.)

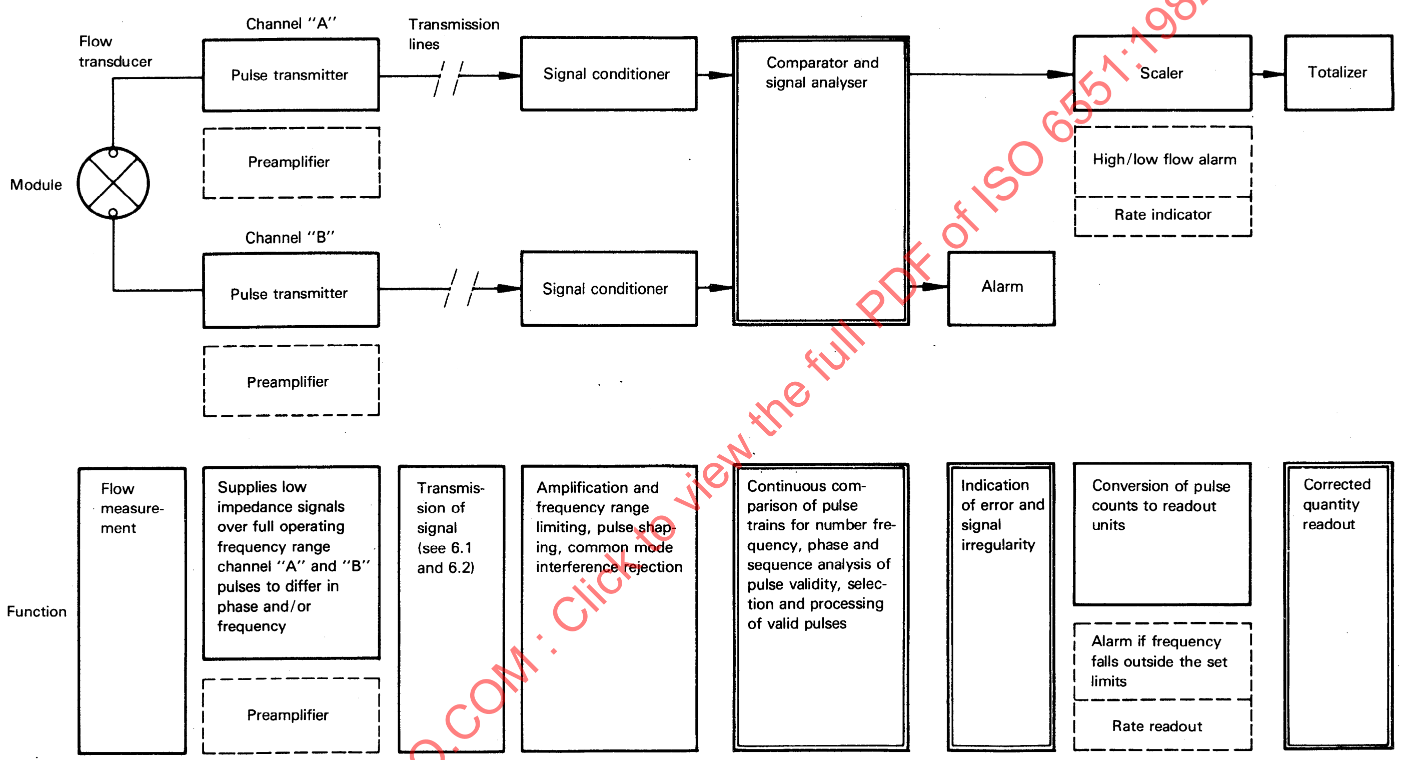

Figure 5 — Typical functional arrangement for pulse security system

Level A. The diagram illustrates a dual transmission system protected both against dynamic faults arising from monitoring of the duplicated pulses and by static tests of the electrical integrity of the transmission circuits. The system should still operate as a Level E system if one of the transmission channels fails. An incidental advantage of Level A is its ability to detect some mechanical faults in the transducer. Simultaneous pulses caused by symmetrical interference are automatically rejected and do not influence the system. Alarm will be given in all circumstances when impaired pulses are received by the comparator. It may be desirable to provide redundancy in one or all of the elements shown. (Note that the modules and functions shown in full are essential. Those shown dotted are optional. The modules and functions boxed in double line indicate the difference from Level B.)

4 System design principles and quality

4.1 Quality of components

It is implicit in this International Standard that only components of specified quality should be used (see the note).

NOTE — The term quality is used in this International Standard in the sense of fitness for purpose.

4.2 General design criteria

4.2.1 The most important consideration is to prevent the occurrence of spurious pulses rather than to rely upon the provision of verification circuitry to provide protection against the results of false measurement.

The design approach should therefore take into account the noise environment.

Low level signals from high impedance sources become attenuated by line losses, and the overall signal-to-noise ratio can further be impaired by the greater probability of noise in longer lines.

Poorly designed units and inadequate regard for noise pick-up can seriously influence the performance of any equipment.

NOTE — A means of reducing the error-sensitivity of equipment is to apply, either separately or in combination, micro-processor technology, or fibre optics or other techniques as a complementary technology. However, the precautions necessary with systems using other technologies are not considered in this International Standard.

4.2.2 Secure and reliable pulsed data-transmission systems should be achieved by concentrating on the elimination of their error-sensitive parts during the design stage. Dual circuits or other techniques aimed at increasing security should be added to guard against influences which are beyond the control of the designer.

Such additions should be adequately designed so as not to introduce noise or other errors.

4.2.3 Designs and standards should not attempt to protect against all theoretical modes of failure, but should be restricted to provide security against known or anticipated problems.

4.3 Secondary indication

Where it is acceptable to the parties concerned in a transaction, ancillary devices need not have as high a degree of security as the primary indication. However, such devices should be given basic approval as part of an overall approval and should be compatible with it.

4.4 Totalizer

It is basic to security requirements that the value of the totalizer count cannot be impaired during a delivery. The use of a non-resettable counter is mandatory for royalty and customs and excise revenue accounting systems and is recommended for all other primary systems.

4.5 Form of tests

4.5.1 Careful consideration should be given to the form of tests to be applied to the electronic system for fidelity and security purposes. The test should take into account the major environmental hazards that experience shows are likely to be encountered on site.

Some major environmental hazards to be explored are typically :

a) the diurnal thermal cycle may cause significant variation in mechanical and electrical components;

b) heavy rain, high pressure water, water cleaning hoses, etc.;

c) electrical interference from mobile compressors and generators;

d) local radio and television transmitters, particularly mobile hand-held sets;

e) local electrical sub-stations with transformers and/or relay control systems.

4.5.2 Inclusion of arrangements to enable the electrical integrity of the system and the power supply to be checked, should be considered at the design stage.

4.6 Signal pre-amplifiers

A signal pre-amplifier may be introduced into the transmission system at the transducer, if transmission distances or manufacturers' requirements so dictate.

4.7 Typical causes of error

Typical causes of error which should be taken into consideration are as follows :

4.7.1 Transients.

4.7.2 Power supply variations.

4.7.3 Power supply interruption.

4.7.4 Inadequate signal level as a result of line loss.

4.7.5 Common-mode noise induced in cabling.

4.7.6 Series-mode noise induced in cabling.

4.7.7 Noise introduced from ground-loop problems.

4.7.8 Excessive gain and frequency response of the system elements.

4.7.9 Spurious signals induced from other meters sharing the same multicore cable.

4.7.10 Short circuit or open circuit of conductor pair or short circuit of either conductor to ground or shield.

4.7.11 Bad connections, temperature variations and extremes, vibration, shock and adverse environmental conditions.

5 Precautions

5.1 General

5.1.1 Sensitivity controls on pre-amplifiers, scalers, etc., should not be capable of unauthorized adjustment.

5.1.2 No malfunction of any measuring equipment should be caused by the following interruptions to the power supply :

a) Zero voltage for 10 ms or less;

b) 50 % of normal voltage for 20 ms or less;

c) 80 % of normal voltage for 50 ms or less.

5.1.3 The totalized pulse counts existing at the time of any power failure, should be retained.

5.1.4 The gain and frequency response of the system elements should be restricted to that required by the application.

5.2 Warning of metering system fault

Notwithstanding that this International Standard deals with the electronic signal system only, where the output of the transducer is likely to be degraded at the extremes of its useable range the metering system may be fitted with a device to give alarms at the limiting flow rates.

5.3 Protection against electrical storms

It is essential that cable pairs and the instrument input circuit should be isolated; this will effectively increase the degree of protection of the equipment from damage by excessive common-mode voltages (electrical storms).

6 Installation

6.1 Signal amplitude

The following points should be observed so that the signal amplitude from the transducer to the receiver can be maintained at a high level.

6.1.1 The installation recommendations specified by the manufacturers should be carefully followed, whilst complying fully with statutory requirements and/or codes of safety.

6.1.2 The length of transmission lines from the meter to the read-out device should be minimized, bearing in mind the requirements of 6.2.1 to 6.2.8 inclusive.

6.1.3 Proper impedance matching should be ensured.

6.1.4 Signal transmission cables that are technically compatible with the duty should be used.

6.1.5 The supply voltages to pre-amplifiers and constant amplitude pulse generating systems should be checked to ensure they are of proper magnitude and do not exceed noise or ripple maxima as specified by the equipment manufacturer.

6.2 Signal-to-noise ratio

The following points should be observed so that the signal-to-noise ratio can be optimized.

6.2.1 Transmission cables with correctly grounded shielding should be provided from meters and meter prover detectors, to minimize noise.

6.2.2 The recommendations of the equipment manufacturers should be followed in the selection of the proper number and size of conductors, and the types of material used in their construction.

6.2.3 The shield of the transmission cable should be grounded at one point only, to prevent the formation of ground-loops.

6.2.4 A continuous run of transmission cables should be used whenever possible. Where joints are unavoidable, continuity of the shield should be ensured. Joints should be encapsulated to maintain the electrical specification and security of the cable.

6.2.5 When multi-readout devices are used and wired in parallel, shielded cables should be used for connecting wiring.

6.2.6 The data-transmission lines should not share a conduit with anything other than shielded cables or cables from direct current sources, for example temperature sensors.

Furthermore, if the maximum electrical power carried by any one transmission cable other than a flow-meter cable, is ten or more times greater than the minimum power carried by any flow-meter signal data-transmission cable, separate conduits should be provided.

6.2.7 Data-transmission cables should not be installed in a parallel run with power cables. Where a parallel run cannot be avoided, the cables should not be closer than 0,5 m, or such greater distance as is specified by the meter manufacturer.

If it is necessary for transmission cables and power cables to cross, this should be at right angles wherever possible.

6.2.8 When transmission cables are run in ducts or inside control cabinets, every attempt should be made to keep the shielded cable bundle intact and separate from other conductors.

6.2.9 All spare data-transmission cables and conductors run in a conduit with an active data-transmission line, should have the shield and conductors grounded at the same single point as the active line.

6.2.10 Several methods of attenuating noise may be used, for example, band-pass filters and isolating transformers.

6.2.11 Separate routing of the two transmission lines enhances the likelihood of detection of noise.

6.3 Protection against noise

a) Individually twisted pairs afford the maximum protection against noise.

b) Helical-lay cables are acceptable for many installations.

c) Parallel-lay cables should be avoided.

d) Line impedance balancing against a virtual earth is an effective way to reduce series mode induction signals, while the influence of common mode signals is largely reduced.

e) Separate routing of the two transmission lines minimizes the effects of noise and enhances the likelihood of noise detection (see 6.2.11).

6.4 Grouping of intrinsically safe cables

The grouping of cables for intrinsically safe circuits with other current-carrying cables requires special consideration and local regulations must be followed together with the requirements of the appropriate safety code.

7 Commissioning and testing

7.1 General

7.1.1 Before the equipment is taken into service, commissioning and testing should be carried out as agreed between manufacturer and user.

7.1.2 When manufacturers are not directly responsible for the commissioning, they should provide guidance to the commissioning engineers to enable them to follow procedures which facilitate this exercise and ensure correct functioning of the system.

The following general rules apply.

7.1.3 Before commissioning an installation or part of an installation, the commissioning engineers should ensure the following :

a) correct mechanical installation of the equipment,

b) satisfactory electrical installation, and

c) satisfactory field cabling.

If the above do not comply with the manufacturer's recommendations and clauses 5 and 6, it is unlikely that the equipment can be correctly commissioned.

Even when the equipment functions correctly, long-term reliability can be impaired by an unsatisfactory installation.

7.1.4 Compliance with the provisions of 8.2 and 8.3 is necessary.

Special attention is drawn to the cautionary note in 8.3.

7.1.5 In certain cases, approving authorities may require to witness commissioning.

7.2 Electrical installation

It is essential that the following aspects of the electrical installation should receive careful attention.

a) The electrical installation should be examined to ensure that it is in accordance with standards for electrical safety adequate for the classification of the areas concerned.

Local regulations should be complied with and reference should be made to an appropriate electrical safety code.

b) The cabling specification should be verified (see 6.1 and 6.2).

c) Particular attention should also be paid to the weatherproofing of the electrical installation, especially the field junction boxes, which are frequently not the system equipment manufacturer's responsibility.

7.3 Testing

7.3.1 The commissioning of different types of systems will demand differing procedures which should be clearly defined by the manufacturer(s).

Many manufacturers are able to provide relatively simple equipment for testing individual parts of a system after installation, and the initial testing and calibration of the equipment can often conveniently be carried out before an attempt is made to check the whole system.

7.3.2 Special attention is drawn to the cautionary note in 8.3.7.

7.3.3 A typical test method which may be used is to inject a train of test pulses into the transmission system at the transmitter connections. This test signal should have an amplitude of not more than 50 % of the normal transmitter signal (see 8.4.4).

The test signal should be monitored by the installed receiving apparatus and the signal received should conform with the test signal to within one pulse in one hundred thousand.

The test should be performed at two conditions which should represent the maximum and minimum flows between which the meter normally operates except during start-up and shutdown.

7.4 Fault-finding

7.4.1 Most manufacturers will provide a fault-finding guide to enable the user quickly to establish the likely cause of any failure. These guides are normally only relevant to a system