

# DATA SHEET

## **TDA8732** NICAM-728 demodulator (NIDEM)

Product specification  
File under Integrated Circuits, IC02

April 1993

**NICAM-728 demodulator (NIDEM)****TDA8732****FEATURES**

- 5 V supplies for analog and digital circuitry
- Low cost application
- Improved noise behaviour
- Limiting amplifier for QPSK input
- Suitable with PAL B, G and I NICAM-728 systems.

**APPLICATIONS**

- NICAM-728 systems.

**GENERAL DESCRIPTION**

The NIDEM is a dedicated device providing a DQPSK (Differential Quadrature Phase Shift Keying) demodulator for a NICAM-728 system.

The device interfaces with NICAM-728 decoders and provides data synchronized to a 728 kHz clock (either supplied externally or by the on-board clock).

The device consists of a costas loop quadrature demodulator, a bit-rate clock recovery and differential decoder with parallel-to-serial conversion.

The Voltage Controlled Oscillator (VCO) used in the costas loop is achieved with a single-pin crystal oscillator. A second single-pin crystal oscillator with a divider chain provides signals at 5.824 MHz and at 728 kHz.

The NIDEM is suitable for PAL B and G (carrier oscillator crystal at 11.7 MHz) and PAL I (carrier oscillator crystal at 13.104 MHz).

**QUICK REFERENCE DATA**

Measured over full voltage and temperature ranges.

| SYMBOL            | PARAMETER                             | MIN. | TYP.   | MAX. | UNIT       |
|-------------------|---------------------------------------|------|--------|------|------------|
| $V_{CCA}$         | analog supply voltage                 | 4.5  | 5      | 5.5  | V          |
| $V_{CCD}$         | digital supply voltage                | 4.5  | 5      | 5.5  | V          |
| $V_{CCA}$         | analog supply voltage                 | 4.5  | 5      | 5.5  | V          |
| $V_{CCA}-V_{CCD}$ | differential supply voltage           | -0.5 | —      | 0.5  | V          |
| $I_{CCA}$         | analog supply current                 | —    | 12.5   | —    | mA         |
| $I_{CCD}$         | digital supply current                | —    | 14.5   | —    | mA         |
| $V_3$             | QPSK input level (peak-to-peak value) | 30   | 100    | 300  | mV         |
| $R_I$             | input resistance                      | 1.75 | 2.5    | 3.25 | k $\Omega$ |
| $C_I$             | input capacitance                     | —    | 2      | —    | pF         |
| $f_{CAROSC}$      | carrier oscillator frequency          | 11.5 | —      | 13.5 | MHz        |
| $f_{XTAL}$        | crystal frequency                     |      |        |      |            |
|                   | PAL B, G                              | —    | 11.7   | —    | MHz        |
| $f_{XTAL}$        | PAL I                                 | —    | 13.104 | —    | MHz        |
| $f_{CLKOSC}$      | clock oscillator frequency            | —    | 11.648 | —    | MHz        |
| $f_{C5M}$         | C5M output frequency                  | —    | 5.824  | —    | MHz        |

**ORDERING INFORMATION**

| EXTENDED<br>TYPE<br>NUMBER | PACKAGE |              |          |                       |
|----------------------------|---------|--------------|----------|-----------------------|
|                            | PINS    | PIN POSITION | MATERIAL | CODE                  |
| TDA8732                    | 20      | DIL          | plastic  | SOT146 <sup>(1)</sup> |

**Note**

1. SOT146-1; 1996 December 3.

## NICAM-728 demodulator (NIDEM)

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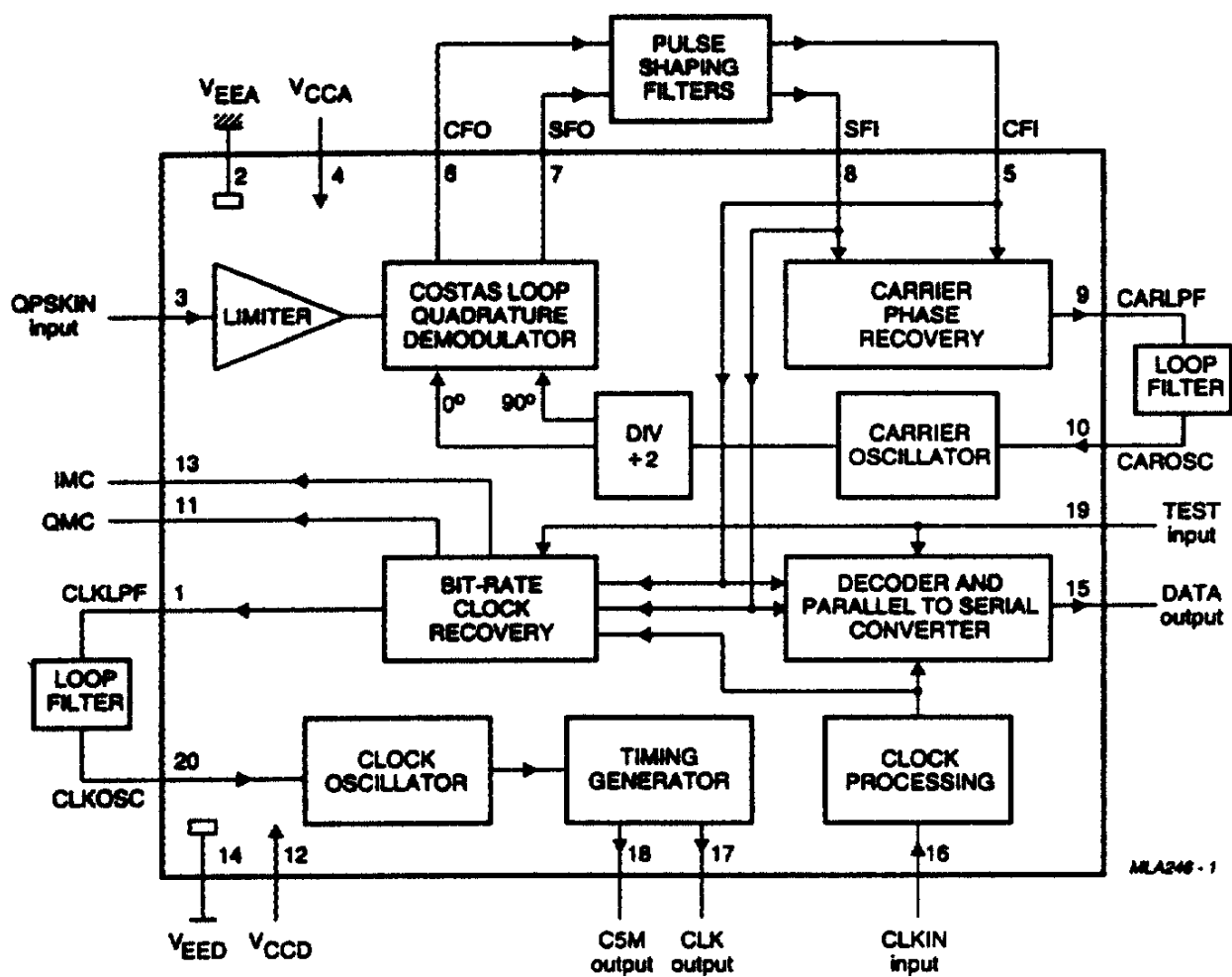


Fig.1 Block diagram.

## NICAM-728 demodulator (NIDEM)

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## PINNING

| SYMBOL           | PIN | DESCRIPTION                                                                |
|------------------|-----|----------------------------------------------------------------------------|
| CLKLPF           | 1   | transconductance output for bit-rate loop low-pass filter                  |
| V <sub>EEA</sub> | 2   | ground for analog circuitry                                                |
| QPSKIN           | 3   | QPSK modulated data input                                                  |
| V <sub>CCA</sub> | 4   | power supply for analog circuitry                                          |
| CFI              | 5   | baseband cosine channel input after filtering                              |
| CFO              | 6   | demodulated cosine channel output to low-pass filter                       |
| SFO              | 7   | demodulated sine channel output to low-pass filter                         |
| SFI              | 8   | baseband sine channel input after filtering                                |
| CARLPF           | 9   | transconductance output for carrier loop low-pass filter                   |
| CAROSC           | 10  | crystal input for carrier oscillator (frequency is 11.7 MHz or 13.104 MHz) |
| QMC              | 11  | monostable components connection for quadrature data transition detector   |
| V <sub>CCD</sub> | 12  | power supply for digital circuitry                                         |
| IMC              | 13  | monostable components connection for in-phase data transition detector     |
| V <sub>EED</sub> | 14  | ground for digital circuitry                                               |
| DATA             | 15  | 728 kbit/s demodulated and differentially decoded serial data output       |
| CLKIN            | 16  | bit-rate clock input at 728 kHz, phase-locked to the data                  |
| CLK              | 17  | output clock frequency at 728 kHz                                          |
| C5M              | 18  | reference frequency output at 5.824 MHz (8 x CLK)                          |
| TEST             | 19  | input for test purpose (grounded for normal operation)                     |
| CLKOS            | 20  | crystal input for clock oscillator (frequency is 11.648 MHz)               |

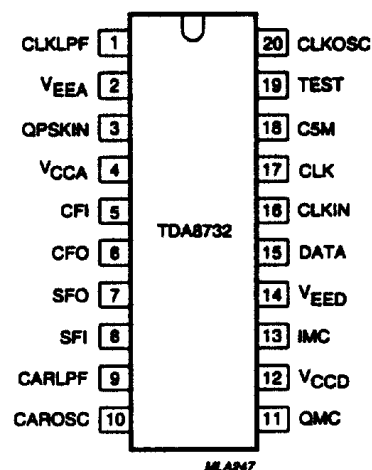


Fig.2 Pin configuration.

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## NICAM-728 demodulator (NIDEM)

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### FUNCTIONAL DESCRIPTION

#### QPSK demodulator

The DQPSK signal input to the demodulator (QPSKIN) is limited and fed into the costas loop demodulator. A single-pin carrier oscillator (CAROSC), at twice the carrier frequency, supplies a differential signal to the divider circuitry, which drives the demodulators with both 0° and 90° phase shift. This produces cosine and sine signals which are required for the carrier recovery. Cosine (in-phase) and sine (in Quadrature) channel baseband filters are then provided externally between pins CFO and CFI, and SFO and SFI respectively. The two filtered baseband signals are then processed to provide an error signal, the magnitude and which of which bear a fixed relationship to the phase error of the carrier, regardless of which of the four rest-states the signal occupies. The carrier recovery loop is closed with the aid of a single pin loop filter connection at CARLPF, which filters the error voltage signal to control the 728 kHz as shown in application diagrams Fig.4 and 5.

#### Bit-rate clock recovery loop

The CFI and SFI channels are processed using edge detectors and monostables, with externally derived time constants (see Fig.3), to generate a signal with a coherent component at the data bit symbol rate. This signal is compared with the clock derived from CLKIN and used to produce an error signal at the transconductance output CLKLPF. This error signal is loop-filtered and used to control the clock generator (at CLKOSC if the on-board clock is used; see Fig.5).

#### Clock oscillator and timing generator

A voltage-controlled oscillator on-board the NIDEM operates at 11.648 MHz and is divided down to produce a 728 kHz (bit-rate) clock output (CLK) which is phase locked to the pulse stream and may be used as an alternative clock input for NIDEM. A reference clock at 5.824 MHz is provided at pin C5M (TTL levels).

#### Differential decoder and parallel-to-serial converter

The recovered symbol-rate clocking-signal (364 kHz) produced internally is passed to the demodulator where it samples the sliced raised cosine pulse stream. The recovered bit-rate clocking-signal is passed to the decoder and is used to differentially decode the demodulated data signal and reform it into a serial bit-stream.

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**LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL           | PARAMETER                                    | MIN. | MAX.             | UNIT |
|------------------|----------------------------------------------|------|------------------|------|
| V <sub>CCA</sub> | analog supply voltage                        | −0.3 | 6                | V    |
| V <sub>CCD</sub> | digital supply voltage                       | −0.3 | 6                | V    |
| QPSKIN           | modulated data input voltage                 | −0.3 | 5.5              | V    |
| CFI              | baseband cosine channel input voltage        | −0.3 | V <sub>CCA</sub> | V    |
| SFI              | baseband sine channel input voltage          | −0.3 | V <sub>CCA</sub> | V    |
| CFO              | demodulated cosine channel output voltage    | −0.3 | 5.5              | V    |
| SFO              | demodulated sine channel output voltage      | −0.3 | 5.5              | V    |
| CAROSC           | crystal input voltage for carrier oscillator | −0.3 | 5.5              | V    |
| CLKOSC           | crystal input voltage for clock oscillator   | −0.3 | 5.5              | V    |
| QMC,IMC          | monostable output voltage                    | −0.3 | V <sub>CCD</sub> | V    |
| DATA             | data output voltage                          | −0.3 | 5.5              | V    |
| CLK              | clock output voltage                         | −0.3 | 5.5              | V    |
| C5M              | reference frequency output voltage           | −0.3 | 5.5              | V    |
| CLKIN            | bit-rate clock input voltage                 | −0.3 | 6                | V    |
| TEST             | input voltage for test purpose               | −0.3 | 6                | V    |
| CLKLPF           | bit-rate loop output voltage                 | −0.3 | 5.5              | V    |
| CARLPF           | carrier loop output voltage                  | −0.3 | 5.5              | V    |
| T <sub>amb</sub> | operating ambient temperature                | 0    | 70               | °C   |
| T <sub>stg</sub> | storage temperature                          | −40  | +125             | °C   |
| T <sub>j</sub>   | maximum junction temperature                 | —    | +125             | °C   |

**THERMAL RESISTANCE**

| SYMBOL              | PARAMETER                            | THERMAL RESISTANCE |
|---------------------|--------------------------------------|--------------------|
| R <sub>th j-a</sub> | from junction to ambient in free air | 80 K/W             |

## NICAM-728 demodulator (NIDEM)

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## CHARACTERISTICS

 $V_{CCA} = 5\text{ V} \pm 10\%$ ;  $V_{CCD} = 5\text{ V} \pm 10\%$ ;  $-0.5\text{ V} < V_{CCA} - V_{CCD} < 0.5\text{ V}$ ;  $T_{amb} = 0\text{ to }70\text{ }^{\circ}\text{C}$ ; unless otherwise specified.

| SYMBOL                     | PARAMETER                                  | CONDITIONS                                             | MIN. | TYP.   | MAX.      | UNIT               |
|----------------------------|--------------------------------------------|--------------------------------------------------------|------|--------|-----------|--------------------|
| <b>Supply</b>              |                                            |                                                        |      |        |           |                    |
| $V_{CCA}$                  | analog supply voltage                      |                                                        | 4.5  | 5      | 5.5       | V                  |
| $V_{CCD}$                  | digital supply voltage                     |                                                        | 4.5  | 5      | 5.5       | V                  |
| $V_{CCA}-V_{CCD}$          | differential supply voltage                |                                                        | -0.5 | –      | 0.5       | V                  |
| $I_{CCA}$                  | analog supply current                      |                                                        | –    | 13     | 17        | mA                 |
| $I_{CCD}$                  | digital supply current                     |                                                        | –    | 13     | 17        | mA                 |
| $P_{tot}$                  | total power dissipation                    |                                                        | –    | 130    | 187       | mW                 |
| <b>Inputs</b>              |                                            |                                                        |      |        |           |                    |
| CLKIN                      |                                            |                                                        |      |        |           |                    |
| $V_{IH}$                   | HIGH level input voltage                   |                                                        | 2    | –      | $V_{CCD}$ | V                  |
| $V_{IL}$                   | LOW level input voltage                    |                                                        | –    | –      | 0.8       | V                  |
| $I_{IH}$                   | HIGH level input current                   | $V_I = 5\text{ V}$                                     | –    | –      | 10        | $\mu\text{A}$      |
| $I_{IL}$                   | LOW level input current                    | $V_I = 0\text{ V}$                                     | -400 | –      | –         | $\mu\text{A}$      |
| QPSKIN                     |                                            |                                                        |      |        |           |                    |
| $f_{QPSKIN}$               | input frequency                            |                                                        | 5    | –      | 7         | MHz                |
| $R_I$                      | input resistance                           | $f = 6\text{ MHz}$                                     | 1.75 | 2.5    | 3.25      | $k\Omega$          |
| $C_I$                      | input capacitance                          | $f = 6\text{ MHz}$                                     | –    | 2      | –         | pF                 |
| SFI, CFI                   |                                            |                                                        |      |        |           |                    |
| $I_b$                      | input bias current                         | $V_{SFI} = 4.3\text{ V}$ ;<br>$V_{CFI} = 4.3\text{ V}$ | –    | –      | 5         | $\mu\text{A}$      |
| $R_I$                      | input resistance                           | $f = 364\text{ kHz}$                                   | 70   | 100    | 130       | $k\Omega$          |
| $C_I$                      | input capacitance                          | $f = 364\text{ kHz}$                                   | –    | 2      | –         | pF                 |
| CAROSC                     |                                            |                                                        |      |        |           |                    |
| $f_{car}$                  | oscillator frequency                       |                                                        | 11.5 | –      | 13.5      | MHz                |
| CARRIER OSCILLATOR CRYSTAL |                                            |                                                        |      |        |           |                    |
|                            | holder                                     |                                                        |      | RW 43  |           |                    |
|                            | nominal frequency with specified load      | $C_L = 15\text{ pF}$                                   |      |        |           |                    |
| $f_{PAL\ I}$               | PAL I                                      |                                                        | –    | 13.104 | –         | MHz                |
| $f_{PAL\ B, G}$            | PAL B, G                                   |                                                        | –    | 11.7   | –         | MHz                |
|                            | vibration mode                             | fundamental                                            |      |        |           |                    |
|                            | circuit condition                          | series resonance                                       |      |        |           |                    |
|                            | adjustment tolerance on frequency at 25 °C |                                                        | -30  | –      | +30       | $10^{-6}$          |
|                            | temperature                                |                                                        | 0    | –      | 70        | $^{\circ}\text{C}$ |
|                            | frequency stability over temperature       |                                                        | -30  | –      | +30       | $10^{-6}$          |
| $C_L$                      | load capacitance                           |                                                        | –    | 15     | –         | pF                 |

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| SYMBOL                      | PARAMETER                                      | CONDITIONS                                       | MIN.                    | TYP.   | MAX. | UNIT                    |
|-----------------------------|------------------------------------------------|--------------------------------------------------|-------------------------|--------|------|-------------------------|
| $R_s$                       | resonance resistance                           | note 1                                           | 15                      | –      | 40   | $\Omega$                |
| $C_m$                       | motional capacitance                           |                                                  | –                       | 21     | –    | fF                      |
| $C_p$                       | parallel capacitance                           |                                                  | –                       | –      | 5    | pF                      |
|                             | drive power level                              |                                                  | –                       | –      | 0.5  | mW                      |
| CLKOSC                      |                                                |                                                  |                         |        |      |                         |
| $f_{clk}$                   | oscillator frequency                           | $C_1 = 15 \text{ pF}$                            | –                       | 11.648 | –    | MHz                     |
| BIT-RATE OSCILLATOR CRYSTAL |                                                |                                                  |                         |        |      |                         |
|                             | holder                                         |                                                  |                         | RW 43  |      |                         |
| $f_{PAL I}$                 | nominal frequency with specified load<br>PAL I | $C_L = 15 \text{ pF}$                            | –                       | 11.648 | –    | MHz                     |
| $f_{PAL B, G}$              | PAL B, G                                       |                                                  | –                       | 11.648 | –    | MHz                     |
|                             | vibration mode                                 | fundamental                                      |                         |        |      |                         |
|                             | circuit condition                              | series resonance                                 |                         |        |      |                         |
|                             | adjustment tolerance on frequency at 25 °C     |                                                  | –30                     | –      | +30  | $10^{-6}$               |
|                             | temperature                                    |                                                  | 0                       | –      | 70   | °C                      |
|                             | frequency stability over temperature           |                                                  | –30                     | –      | +30  | $10^{-6}$               |
| $C_L$                       | load capacitance                               |                                                  | –                       | 15     | –    | pF                      |
| $R_s$                       | resonance resistance                           | note 1                                           | 15                      | –      | 40   | k $\Omega$              |
| $C_m$                       | motional capacitance                           |                                                  | –                       | 21     | –    | fF                      |
| $C_p$                       | parallel capacitance                           |                                                  | –                       | –      | 5    | pF                      |
|                             | drive level                                    |                                                  | –                       | –      | 0.5  | mW                      |
| Outputs                     |                                                |                                                  |                         |        |      |                         |
| CFO, SFO                    |                                                |                                                  |                         |        |      |                         |
| $R_O$                       | output impedance                               | $f = 364 \text{ kHz}$                            | –                       | 110    | 200  | $\Omega$                |
| $V_{amp}$                   | signal amplitude (peak-to-peak value)          |                                                  | 0.8                     | 1      | –    | V                       |
| CARLPF                      |                                                |                                                  |                         |        |      |                         |
| $V_{OL}$                    | LOW level output voltage                       | $I_{OL} = 100 \text{ }\mu\text{A}$               | –                       | –      | 0.4  | V                       |
| $V_{OH}$                    | HIGH level output voltage                      | $I_{OH} = -100 \text{ }\mu\text{A}$              | $V_{CCD} - 1 \text{ V}$ | –      | –    | V                       |
| $gm \phi 1$                 | phase comparator transconductance gain         | $V_O = 0.4 \text{ V}$ to $V_{CCD} - 1 \text{ V}$ | 100                     | 125    | –    | $\mu\text{A}/\text{rd}$ |
| $I_{LO}$                    | output leakage current for $\pi/4$ phase shift |                                                  | –5                      | –      | 5    | $\mu\text{A}$           |
| CLKLPF                      |                                                |                                                  |                         |        |      |                         |
| $V_{OL}$                    | LOW level output voltage                       | $I_{OL} = 100 \text{ }\mu\text{A}$               | –                       | –      | 0.4  | V                       |

## NICAM-728 demodulator (NIDEM)

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| SYMBOL                                                            | PARAMETER                              | CONDITIONS                       | MIN.           | TYP.  | MAX.      | UNIT       |
|-------------------------------------------------------------------|----------------------------------------|----------------------------------|----------------|-------|-----------|------------|
| $V_{OH}$                                                          | HIGH level output voltage              | $I_{OH} = -100\ \mu A$           | $V_{CCD}-1\ V$ | –     | –         | V          |
| $gm\ \phi 2$                                                      | phase comparator transconductance gain | $V_O = 0.4\ V$ to $V_{CCD}-1\ V$ | 50             | 65    | –         | $\mu A/rd$ |
| $I_{LO}$                                                          | off-state output leakage current       |                                  | –5             | –     | 5         | $\mu A$    |
| IMC, QMC (TYPICAL RC NETWORK; $R = 22\ k\Omega$ ; $C = 150\ pF$ ) |                                        |                                  |                |       |           |            |
| $t_{REC}$                                                         | monostable recovery time               |                                  | –              | –     | 600       | ns         |
| $t_{on}$                                                          | monostable time                        |                                  | –              | 1.37  | –         | $\mu s$    |
| CLK, C5M                                                          |                                        |                                  |                |       |           |            |
| $V_{OL}$                                                          | LOW level output voltage               | $I_{OL} = 1\ mA$                 | –              | –     | 0.4       | V          |
| $V_{OH}$                                                          | HIGH level output voltage              | $I_{OH} = -100\ \mu A$           | 2.4            | –     | $V_{CCD}$ | V          |
| $t_r$                                                             | rise time                              | $C_L = 15\ pF$ ; see Fig.3       | –              | 20    | –         | ns         |
| $t_f$                                                             | fall time                              | $C_L = 15\ pF$ ; see Fig.3       | –              | 20    | –         | ns         |
| $f_{C5M}$                                                         | C5M reference frequency                |                                  | –              | 5.824 | –         | MHz        |
| DATA                                                              |                                        |                                  |                |       |           |            |
| $V_{OL}$                                                          | LOW level output voltage               | $I_{OL} = 1\ mA$                 | –              | –     | 0.4       | V          |
| $V_{OH}$                                                          | HIGH level output voltage              | $I_{OH} = -100\ \mu A$           | 2.4            | –     | $V_{CCD}$ | V          |
| $t_r$                                                             | rise time                              | $C_L = 15\ pF$ ; see Fig.3       | –              | 30    | –         | ns         |
| $t_f$                                                             | fall time                              | $C_L = 15\ pF$ ; see Fig.3       | –              | 30    | –         | ns         |
| CLOCK TIMING                                                      |                                        |                                  |                |       |           |            |
| $t_d$                                                             | CLK to C5M delay (pin 17 to 18)        |                                  | –              | 15    | –         | ns         |
| $t_d$                                                             | CLKIN to DATA delay (pin 16 to 15)     | $V_{CCD} = 4.5\ V$               | –              | 520   | 585       | ns         |

**Note**

1. Only the maximum value is relevant with a  $15\ \Omega$  resistor in series with the crystal (due to the application requirements).

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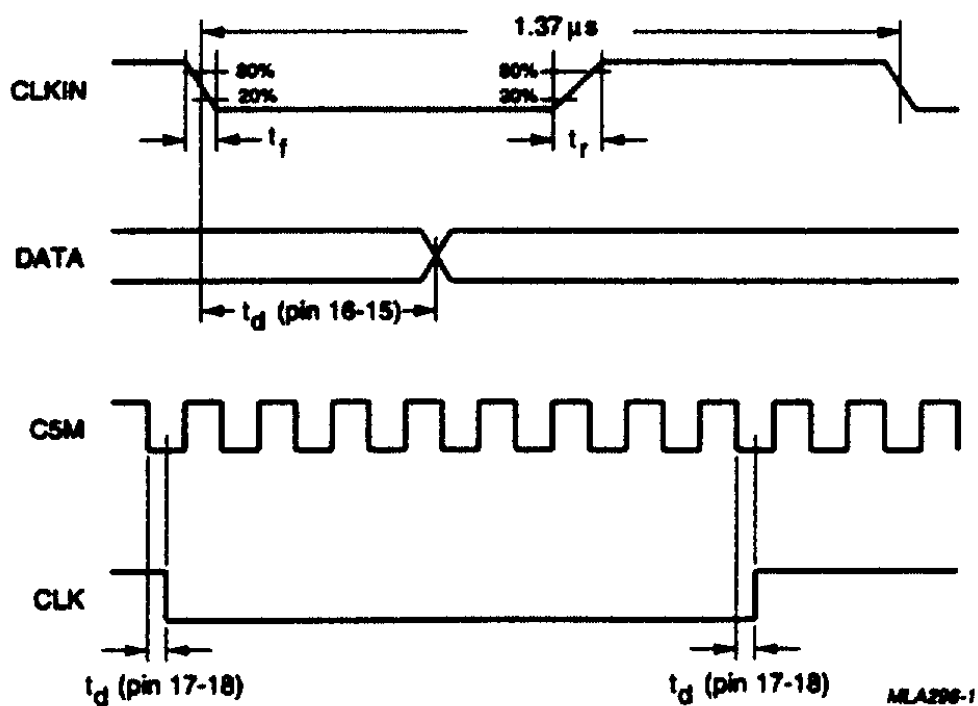


Fig.3 Data timing diagram.

## NICAM-728 demodulator (NIDEM)

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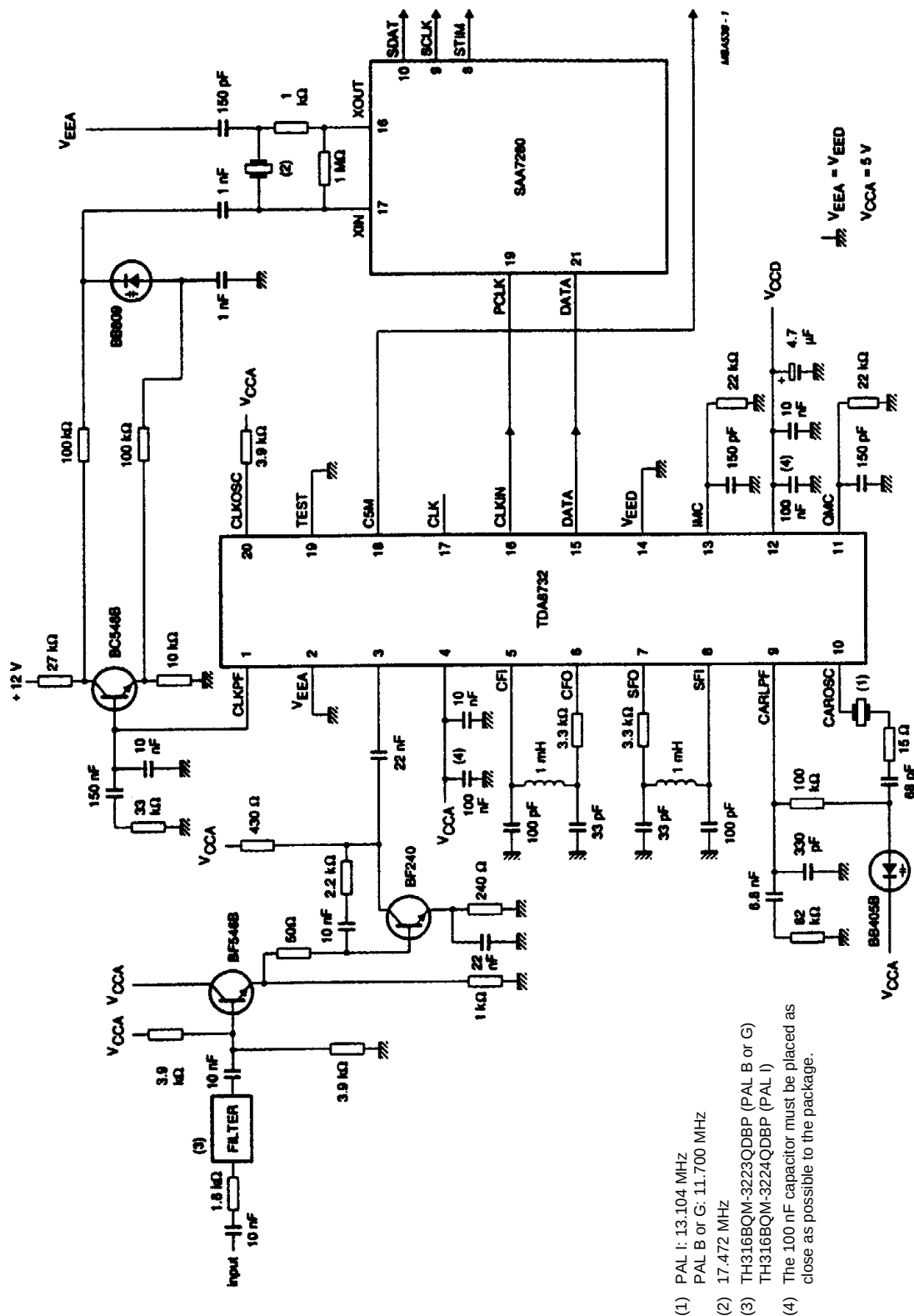


Fig.4 Typical application diagram with the SAA7280.

## NICAM-728 demodulator (NIDEM)

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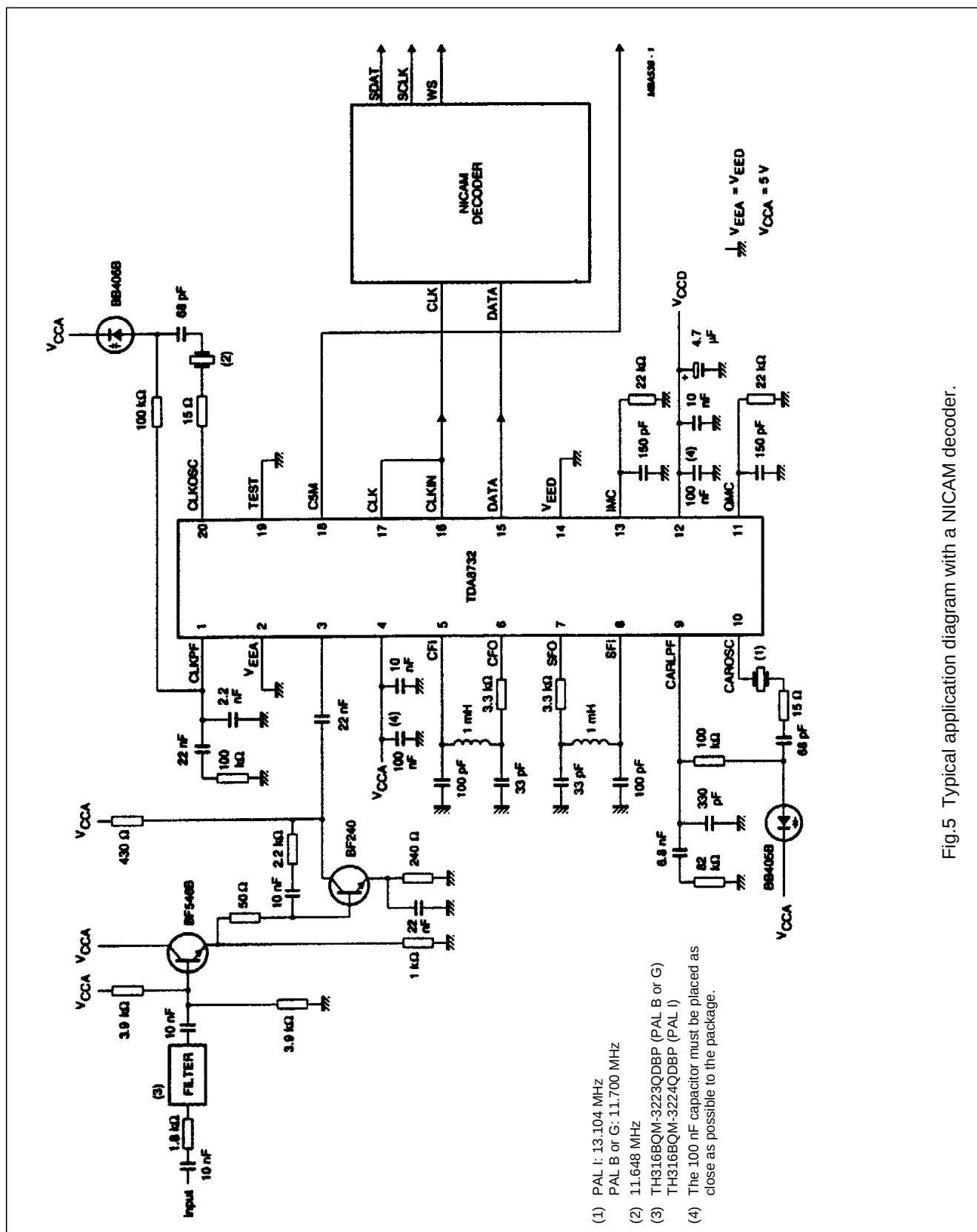


Fig.5 Typical application diagram with a NICAM decoder.

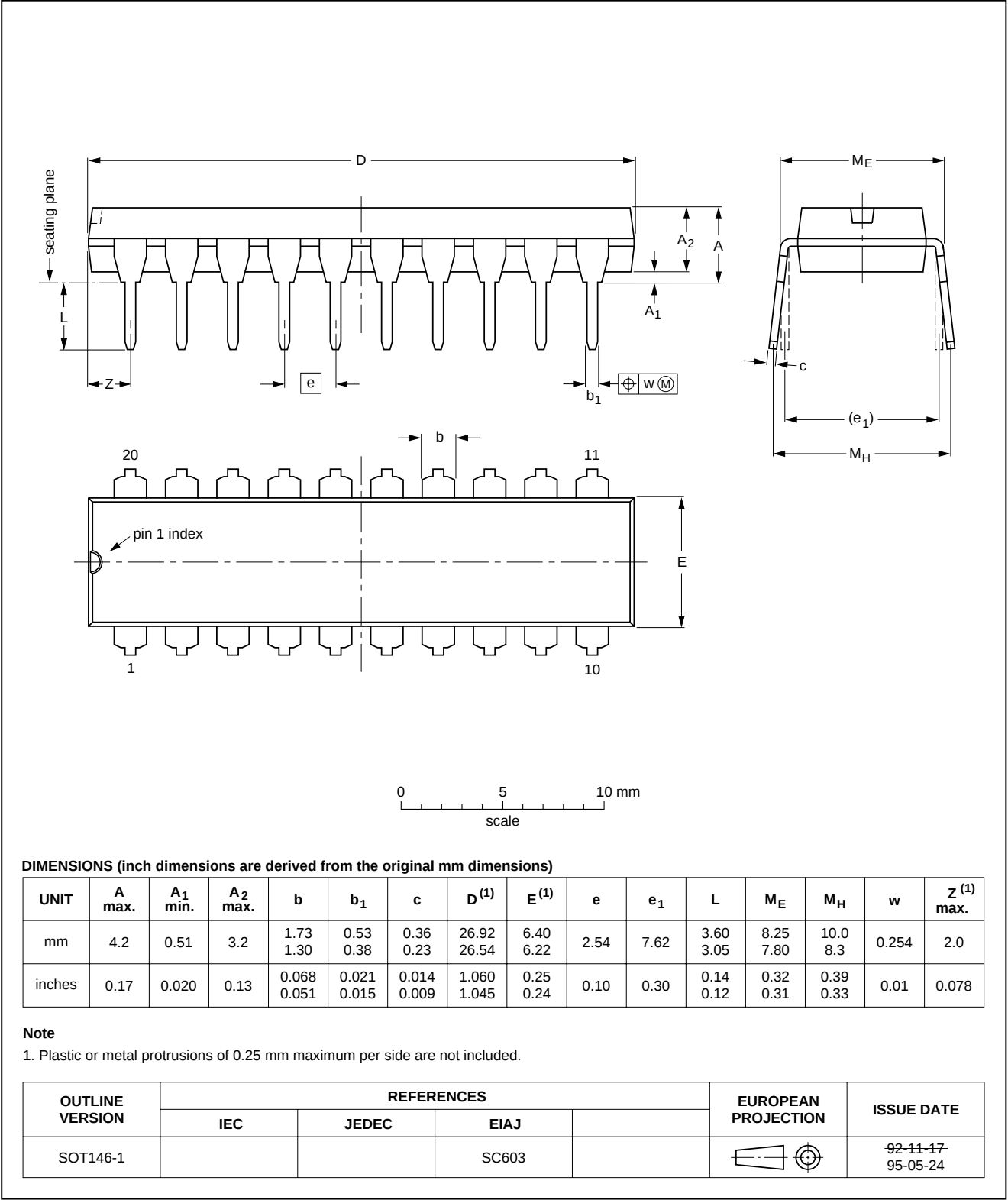
NICAM-728 demodulator (NIDEM)

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PACKAGE OUTLINE

DIP20: plastic dual in-line package; 20 leads (300 mil)

SOT146-1



## NICAM-728 demodulator (NIDEM)

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**SOLDERING****Introduction**

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

**Soldering by dipping or by wave**

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact

with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ( $T_{stg\ max}$ ). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

**Repairing soldered joints**

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

**DEFINITIONS**

| <b>Data sheet status</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Objective specification                                                                                                                                                                                                                                                                                                                                                                                                                                   | This data sheet contains target or goal specifications for product development.       |
| Preliminary specification                                                                                                                                                                                                                                                                                                                                                                                                                                 | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification                                                                                                                                                                                                                                                                                                                                                                                                                                     | This data sheet contains final product specifications.                                |
| <b>Limiting values</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                       |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. |                                                                                       |
| <b>Application information</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                       |
| Where application information is given, it is advisory and does not form part of the specification.                                                                                                                                                                                                                                                                                                                                                       |                                                                                       |

**LIFE SUPPORT APPLICATIONS**

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.