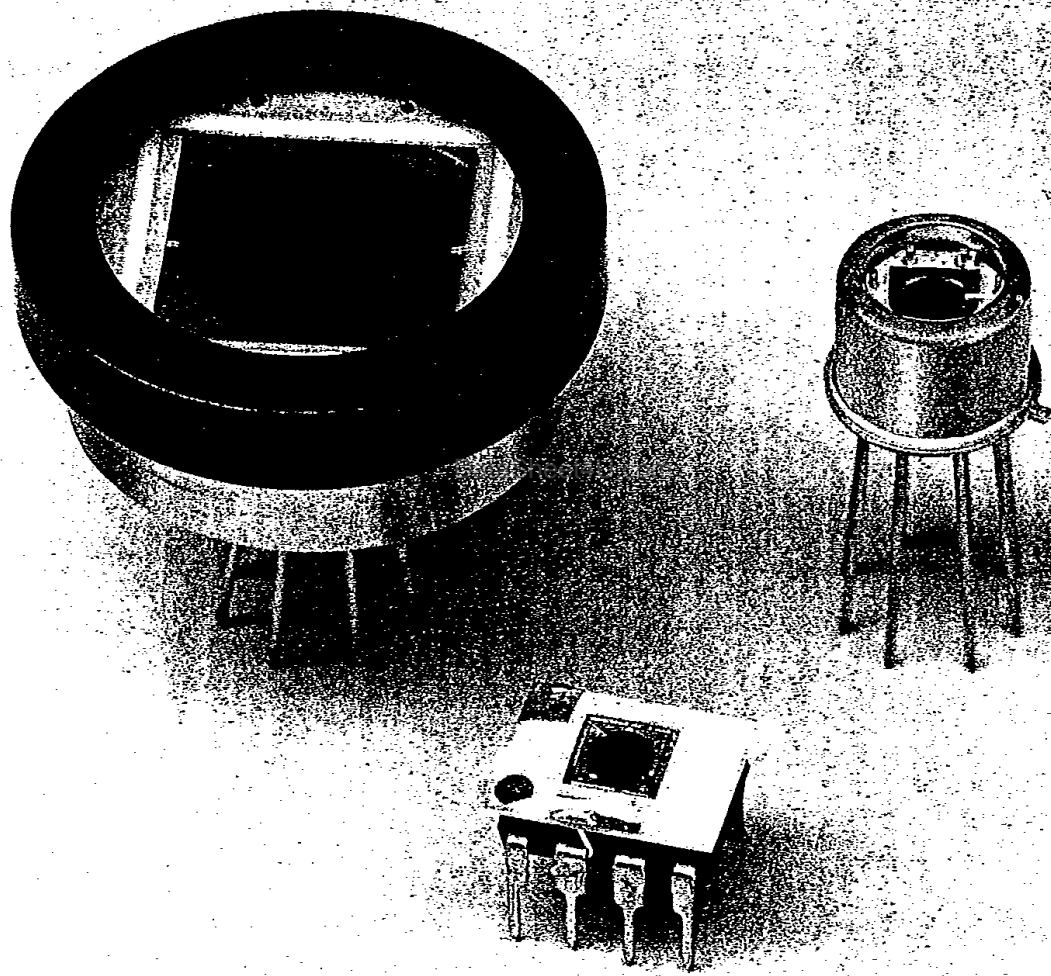


# PHOTOPS™

## HYBRID PHOTODETECTOR/AMPLIFIERS



DataSheet



**UNITED DETECTOR TECHNOLOGY**  
A Division of ILC Technology, Inc.

## Hybrid Photodetector/Amplifiers

### APPLICATIONS

- Laser Power Measurements
- Colorimeter
- Medical Analytical Instrumentation
- Laser Communications
- Industrial Processing Equipment
- Pollution Monitoring Instrumentation
- Optical Measurements Instrumentation
- Spectroradiometers
- Densitometers

PHOTOPS are high-speed, solid-state photodetectors with integral electronics. Their ultrasensitive silicon photodiodes detect light over a wide range of intensities. Built-in monolithic JFET operational amplifiers allow low-level measurements and ensure low-noise output under a variety of operating conditions.

UDT PHOTOPS are used in many different applications, ranging from medical diagnostic instrumentation to bar code readers for business and industrial use.

### STANDARD PHOTOPS.

Numerous detector and packaging configurations are available to assist design engineers in selecting system components.

**UDT-451** is a low-cost PHOTOP in an 8-pin mini-DIP package.

**UDT-455** is a general purpose PHOTOP with a 5.1mm<sup>2</sup> active area, packaged in a TO-5 housing.

**UDT-455HS** is a very high speed version of the UDT-455. Its amplifier is decompensated, for high speed use.

**UDT-455UV** is a UV-enhanced version of the UDT-455.

**UDT-020D** is a general purpose PHOTOP with a 20mm<sup>2</sup> active area, packaged in a TO-8 housing.

**UDT-020UV** is a UV-enhanced version of the UDT-020D.

**UDT-055UV** is a UV-enhanced detector with a 50mm<sup>2</sup> active area.

**UDT-555D** is a general purpose PHOTOP with a 100mm<sup>2</sup> active area, packaged in a UDT metal case.

**UDT-555UV** is a UV-enhanced version of the UDT-555D.

### LOW-NOISE DETECTORS.

UDT photodiodes employ state-of-the-art technology to provide rugged detectors with high-speed and low-noise for low level measurements. PHOTOP general purpose sensors have a spectral range of 350 to 1100 nm. UV-enhanced models incorporate recent technological advancements which extend their capability down to 200 nm. High frequency response permits use of PHOTOP sensors for pulse operation and for rapid scanning requirements. And choice can be made between photo-voltaic and photoconductive modes of detector operation.

### VERSATILE AMPLIFIERS.

The PHOTOPS series utilizes amplifiers with very low voltage and current errors. In addition, PHOTOPS provide design engineers with the flexibility they need for circuit design. Since the customer usually provides his own feedback components, gain can be adjusted in accordance with system needs. And the low-impedance output of the built-in operational amplifier protects against noise pickup from the environment.

### PACKAGE SELECTION.

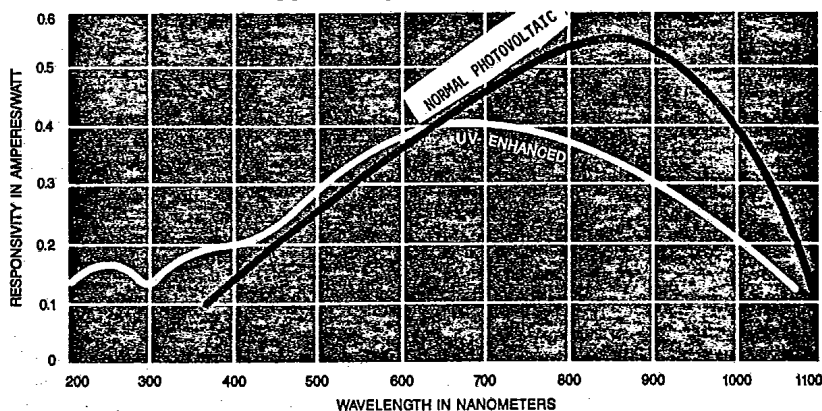
A variety of standard packaging is available. The low-cost mini-DIP package permits photodetectors to be inserted into standard sockets on printed circuit boards. Other detectors are available in standard TO-5 and TO-8 housings. The UDT-020D and UDT-020UV feature electrical case isolation.

### CUSTOM SENSORS.

United Detector Technology welcomes inquiries for custom PHOTOP detectors. All design and manufacturing are performed in our modern facility in California.

Typical requests include changes in detector size, spectral characteristics and speed of response. Also, custom feedback components can be encapsulated to provide fixed gain, so that all detectors can be delivered with a standard sensitivity range.

Typical Spectral Response.



MODEL #	ACTIVE SURFACE		SPECTRAL RANGE		RESPON-SIVITY		CAPACITANCE			SHUNT RESIST-ANCE	DARK CURRENT (V <sub>D</sub> = 10V)	NEP (AT 254nm FOR UV DEVICES) (AT 850nm FOR ALL OTHERS)		BREAKDOWN VOLTAGE (I <sub>D</sub> = 10μA)	TEMP. RANGE	
	AREA	DIA.	MIN.	MAX.	254nm	850nm	0V	10V	50V			0V	10V		V	OPERATING
	mm <sup>2</sup>	In.	nm	nm	A/W	A/W	pF	pF	pF	MΩ	nA	W/√Hz	W/√Hz	°C		°C
UDT-451*	5.1	0.100	350	1100	—	0.5	50	15	7	50	100	3.5 x 10 <sup>-14</sup>	3.6 x 10 <sup>-13</sup>	50	0 to +70	-65 to +125
UDT-455**	5.1	0.100	350	1100	—	0.5	50	15	7	100	20	2.5 x 10 <sup>-14</sup>	1.6 x 10 <sup>-13</sup>	50	0 to +70	-65 to +125
UDT-455HS	5.1	0.100	350	1100	—	0.5	50	15	7	100	20	2.5 x 10 <sup>-14</sup>	1.6 x 10 <sup>-13</sup>	50	0 to +70	-65 to +125
UDT-455UV	5.1	0.100	200	1100	0.15	—	350	80	—	100	30	8.4 x 10 <sup>-14</sup>	6.5 x 10 <sup>-13</sup>	25	0 to +70	-65 to +125
UDT-020D	20	0.197	350	1100	—	0.5	310	60	28	50	50	7.1 x 10 <sup>-14</sup>	2.5 x 10 <sup>-13</sup>	50	0 to +70	-65 to +125
UDT-020UV	20	0.197	200	1100	0.15	—	1000	250	—	50	60	1.2 x 10 <sup>-13</sup>	9.2 x 10 <sup>-13</sup>	25	0 to +70	-65 to +125
UDT-055UV	50	0.314	200	1100	0.15	—	2500	650	—	20	100	1.9 x 10 <sup>-13</sup>	1.2 x 10 <sup>-12</sup>	25	0 to +70	-65 to +125
UDT-555D**	100	0.444	350	1100	—	0.5	1100	350	190	20	200	5.7 x 10 <sup>-14</sup>	5.0 x 10 <sup>-13</sup>	50	0 to +70	-65 to +125
UDT-555UV	100	0.444	200	1100	0.15	—	4500	1200	—	10	200	2.7 x 10 <sup>-13</sup>	1.7 x 10 <sup>-12</sup>	25	0 to +70	-65 to +125

\*The UDT-451 is also available in a UV-enhanced version as a custom device, on special order.

\*\*The UDT-455 has replaced the UDT-450, and the UDT-555D has replaced the UDT-500D. If, however, the UDT-450 or UDT-500D has already been designed into your system, UDT will supply these devices on a special order basis.

## Amplifier Specifications

Specifications at 22° C.

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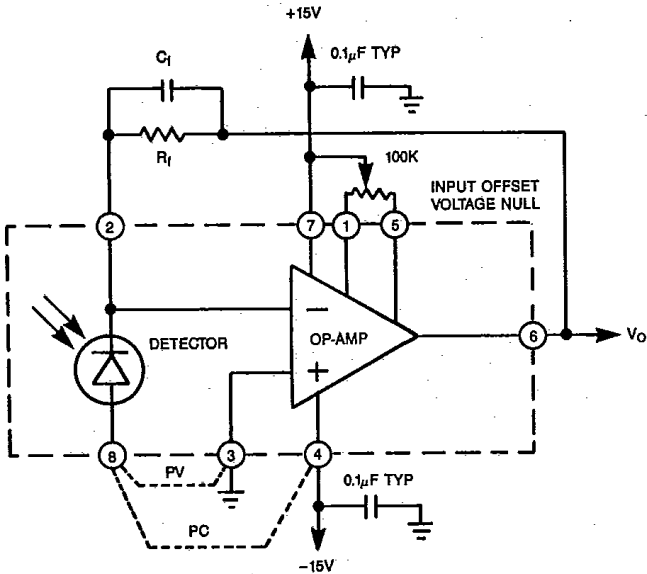
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MODEL #	SUPPLY VOLTAGE			QUIESCENT SUPPLY CURRENT (±15 VDC)		INPUT OFFSET VOLTAGE		TEMPERATURE COEFFICIENT OF INPUT OFFSET VOLTAGE		INPUT BIAS CURRENT		GAIN BANDWIDTH PRODUCT		SLEW RATE		OPEN LOOP GAIN (DC)		INPUT NOISE VOLTAGE		INPUT NOISE CURRENT
	MIN.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.	MIN.	TYP.	MIN.	TYP.	MIN.	TYP.	100 Hz	1 kHz	100 Hz
	V	V	V	mA	mA	mV	mV	μV/°C	μV/°C	pA	pA	MHz	MHz	V/μS	V/μS	V/mV	V/mV	nV/√Hz	nV/√Hz	pA/√Hz
UDT-451	±5	±15	±18	1.4	2.5	3	6	10	—	30	200	—	3	—	13	50	200	25	18	0.01
UDT-455	±5	±15	±18	2.7	5.0	0.5	3	4	15	15	200	3.3	5.4	5	15	50	200	20	15	0.01
UDT-455HS	±5	±15	±18	4.8	8.0	0.5	3	4	15	15	200	11	26	25	62	50	200	20	15	0.01
UDT-455UV	±5	±15	±18	2.7	5.0	0.5	3	4	15	15	200	3.3	5.4	5	15	50	200	20	15	0.01
UDT-020D	±5	±15	±18	2.7	5.0	0.5	3	4	15	15	200	3.3	5.4	5	15	50	200	20	15	0.01
UDT-020UV	±5	±15	±18	2.7	5.0	0.5	3	4	15	15	200	3.3	5.4	5	15	50	200	20	15	0.01
UDT-055UV	±5	±15	±18	2.7	4.0	0.4	1	3	10	40	200	3.5	5.6	7.5	16	50	200	20	15	0.01
UDT-555D	±5	±15	±18	2.7	4.0	0.4	1	3	10	40	200	3.5	5.6	7.5	16	50	200	20	15	0.01
UDT-555UV	±5	±15	±18	2.7	4.0	0.4	1	3	10	40	200	3.5	5.6	7.5	16	50	200	20	15	0.01

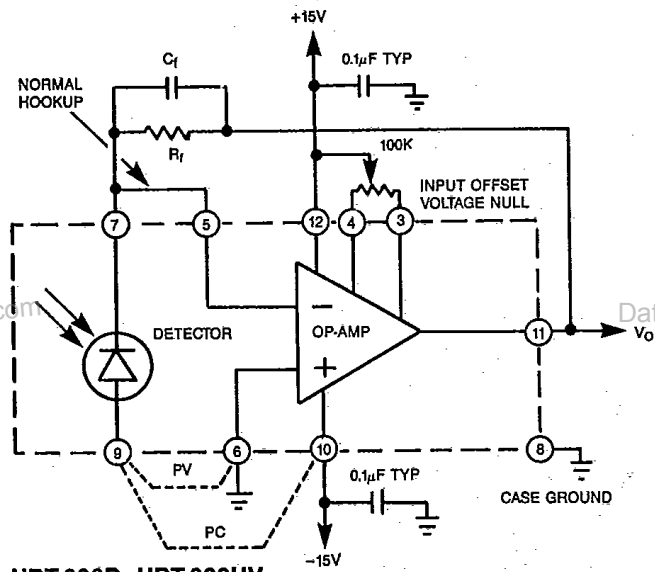
With typical external connections shown.

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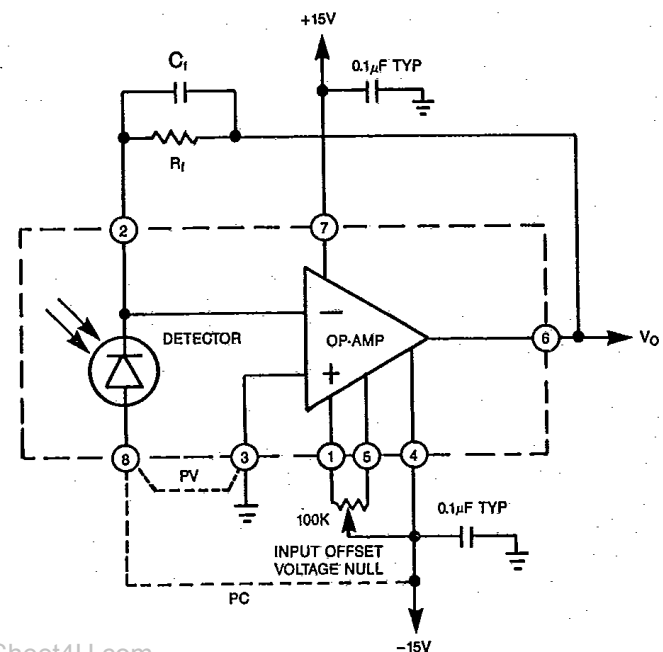


**UDT-455, UDT-455HS, UDT-455UV, UDT-055UV, UDT-555D, UDT-555UV**

Note: For UDT-455HS, minimum recommended feedback resistance is 100K.



**UDT-020D, UDT-020UV**



**UDT-451**

Note: Do not solder leads for this device. Use a DIP socket.

**EFFECTIVE LOAD SEEN BY DETECTOR:**

$$R_L = \frac{R_f}{A_o}$$

Where  $A_o$  = open loop gain of op-amp  
 $R_f$  = feedback resistance

**OUTPUT VOLTAGE:**

$$V_o = I_p R_f = (P_{in} \times R) R_f$$

Where  $I_p$  = photodiode output current  
 $P_{in}$  = optical power in watts  
 $R$  = responsivity in amps/watt

**ZERO SIGNAL OUTPUT ERROR:**

$$V_o = R_f (I_b + I_D) + V_{OS} (1 + \frac{R_f}{R_{sh}})$$

Where  $I_b$  = amplifier bias current  
 $I_D$  = detector dark current at operating bias voltage  $V_D$  ( $I_D = 0$  at  $V_D = 0$ )  
 $V_{OS}$  = amplifier input offset voltage  
 $R_{sh}$  = detector shunt resistance (when  $V_D = 0$ )  
 $= \frac{V_D}{I_D}$  if biased

**GAIN BANDWIDTH PRODUCT:**

For desired gain  $R_f$  and maximum operating frequency  $f$ , the feedback capacitor value required is:

$$C_f = \frac{1}{2\pi f R_f}$$

For the Gain Bandwidth Product (GBP) required of the op-amp, the maximum stable 3 dB frequency is:

$$f_{max} = \sqrt{\frac{GBP}{2\pi R_f (C_j + C_i)}}$$

Where  $C_j$  = Diode capacitance

For example:

For a gain of  $R_f \sim 10^8$ , at operating frequency  $f \sim 100$  Hz, and with an op-amp GBP  $\sim 5$  MHz:

$$C_f \sim \frac{1}{2\pi f R_f} = 15.915 \text{ pF}$$

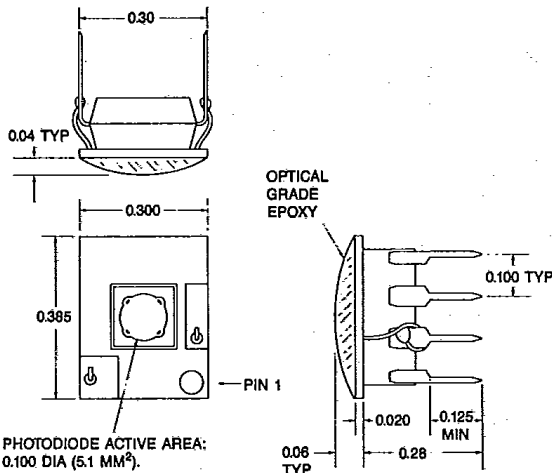
$$f_{max} \sim \sqrt{\frac{GBP}{2\pi R_f (C_j + C_i)}}$$

for  $C_j \sim 15$  pF and  $C_i \sim 16$  pF. The circuit is stable since  $f_{max} \gg f$ .

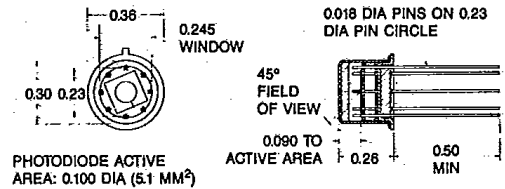
# MECHANICAL DETAILS

## Photops™ Hybrid Photodetector/Amplifiers

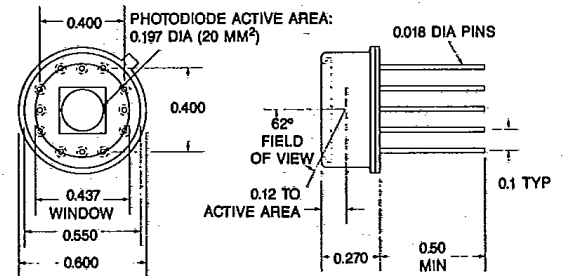
- NOTES: 1. Dimensions in inches, unless otherwise specified.  
 2. Typical centering of detector chip is  $\pm 0.010$  inch.  
 3. UV-enhanced detectors have quartz windows.



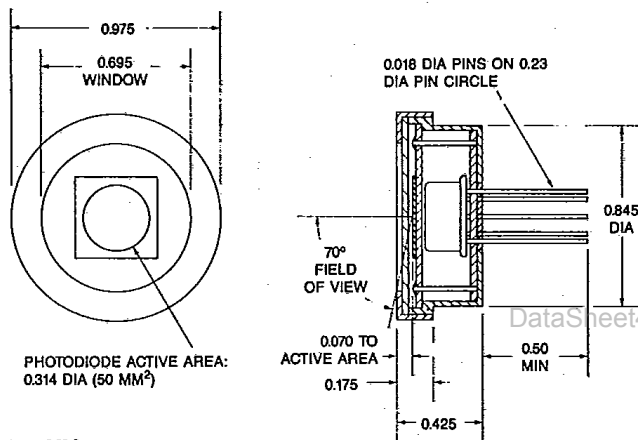
UDT-451



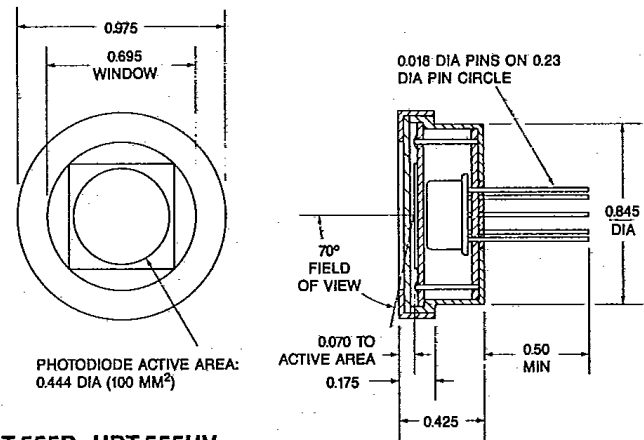
UDT-455, UDT-455HS, UDT-455UV



UDT-020D, UDT-020UV

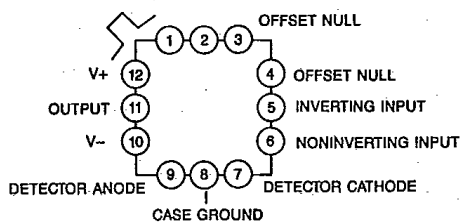


UDT-055UV

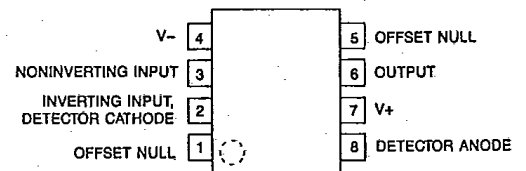


UDT-555D, UDT-555UV

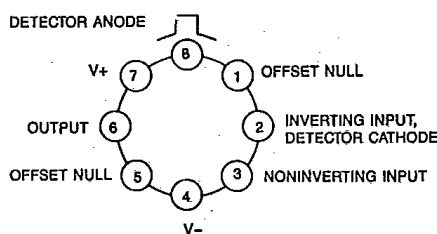
### ELECTRICAL PINOUTS, BOTTOM VIEW



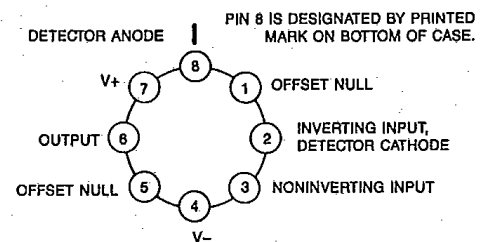
UDT-020D, UDT-020UV



UDT-451



UDT-455, UDT-455HS, UDT-455UV



UDT-055UV, UDT-555D, UDT-555UV